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SELECTION OF UNIVERSITY STUDENTS

THERE are now some thirty thousand more university students in Great Britain than there were in 1938, and of the twenty-two thousand students admitted for the first time in each of the past two years, about fifteen thousand were assisted from public funds. Nevertheless, there are still more candidates than there are places available and, while in Britain it has always been agreed that the right of selection must rest ultimately with the universities, the situation is complicated by the fact that the decision as to awards rests with local education authorities. Moreover, for most candidates an award is a pre-condition of becoming a student, and, apart from the dangers and disadvantages of divided responsibility for selection, the greater dependence upon public awards of most students to-day makes it important that all possible care should be taken to avoid the waste of public money entailed by the admission of unsatisfactory students. While the principle of rigorous selection can be pressed too far, because the year at a university is not necessarily always a wasted year to the student who is rejected at the end of that period, it is none the less true, as Political and Economic Planning points out in a recent broadsheet, "Choosing University Students" (No. 357 ; November 23, 1953), that a reduction in the rate of failure among students would be equivalent to an expansion in the work of the universities, provided it was achieved by more efficient selection and not by lowering university standards.

There is not at present on average a great excess of demand for university places, but during the next decade the number of potential candidates should increase by at least a third. Present plans do not contemplate anything like a corresponding overall expansion of university facilities, and Political and Economic Planning concludes that present methods of selection do not enable universities to predict accurately whether or not a candidate will do well. Many local authorities, disturbed by the high rate of failures among students maintained by them, impose their own tests in addition to those imposed by the university. Political and Economic Planning regards it as highly improbable that such tests materially improve the efficiency of selection as judged by the student's subsequent performance at the university. Relatively inaccurate prediction may mean not only that unsuitable candidates are admitted but also that candidates who could profit by a university education are being excluded.

Accordingly, Political and Economic Planning finds that it is very difficult to say whether, on present standards of university work, too many or too few students are admitted. Merely raising the standards of admission (in terms of advanced-level subjects in the General Certificate of Education examinations) until the supply of students equals the existing, or a smaller, number of university places would of itself offer no solution. The number of absolute and relative failures would still be high if

this process were carried to the extreme length of admitting only those who now obtain scholarships: of all State and university scholars who sat (or should have sat) for finals in 1950–51, nearly a quarter did not take the examination or failed to get the first- or second-class honours expected of them. Of those who actually sat, about one-fifth failed to get firsts or seconds. Such information as is available does not suggest that students who get local awards or who pay their own fees achieve markedly worse results than those selected by the stricter standards of State and university scholarships.

Current methods of selection are based largely on the candidates' showing in one examination or another, together with supplementary evidence provided by headmasters' reports or by interviews where necessary. These methods fail to take into account some of the qualities which go to make a good student, and while some investigations into selection techniques are proceeding, especially by the Nuffield Foundation and the Medical Research Council, the general conclusion so far to be drawn from such studies is that mental tests and group interviews are insufficiently developed to warrant their extensive use in university selection. Used in conjunction with existing methods, they are of value, probably at departmental rather than faculty value; however, when the results of the Nuffield Foundation and the Medical Research Council inquiries are available, they may considerably influence not only the techniques of selection but also the content of university courses and methods of university teaching.

References to the subject in the last report of the University Grants Committee suggest that the Committee is unlikely to overlook these wider implications and that, though it is unlikely that a single compendious test will be found which, applied at the school-leaving stage, will enable accurate forecasts of performance to be made, closer co-operation between the schools and the universities will do much to achieve the desired result. As the Political and Economic Planning broadsheet points out, it is relatively easy to pick out those who are unlikely to be successful after a few terms at the university. If, however, the different approach suggested in the broadsheet is to be adopted, closer agreement between the schools and the universities in regard to standards and the content of courses will be desirable to keep waste within bounds. A more liberal policy of admissions, with a more rigorous weeding-out of unsatisfactory students at the end of the first year, could otherwise easily be abused, and in any event could scarcely be administered without friction unless there was first put into force the main recommendation of the broadsheet—that the granting of an award should automatically follow acceptance of a student by a university.

While on the evidence of this broadsheet the increase in the number of applications is unlikely to be very large, if the central government assumed full financial responsibility for all awards and not merely for sixty per cent of their cost as at present, responsibility for selection would then rest, as it should, solely with the universities. The local education authorities would be relieved of a responsibility for which they are unfitted and which many of them do not desire, and all candidates would have at least an equal chance of being considered for a place.

THE EXPANDING WORLD OF MICROBIOLOGY

Annual Review of Microbiology
Vol. 7. Edited by Charles E. Clifton. Pp. x + 305. (Stanford, California: Annual Reviews, Inc., 1953.) 6 dollars.

MEN of science in general believe that their susceptibility to gastric ulcer is higher than that of the general population, and one of the causes of this state of affairs is the need for the scientific worker of to-day to keep level with an enormous, indigestible and expanding volume of literature. It is sufficiently difficult for him to keep pace with advances in his own field of interest; but when, as so frequently happens, that field touches on others, or when he commits himself to give a course of lectures, then his difficulties become really formidable and he flies to the nearest, and latest, volume of the "Annual Reviews".

The microbiologist in particular has a very wide range of relevant matter before him; this is emphasized by the literature collected in the present "Annual Review of Microbiology", in which there are to be found references to some two hundred and fifty different journals ranging from the *Journal of Psychology* to *Sewage and Industrial Wastes*. Every microbiologist acknowledges his debt to those who have undertaken the surveys and compilations included in these admirable reviews—to those who, from their diffident and cautious introductory remarks, clearly realize the immensity and importance of their task. To quote two such contributors: "It is impossible to offer here even mention of all pertinent work"; and "trying to review comprehensively . . . is a hopeless undertaking". The amount of ground to be covered, the technical detail and high-pressure condensation of material makes the "Annual Reviews" essentially reference works, to be compared for light reading with "Bradshaw". In the present issue, there are nineteen articles with an average of 184 references each, only three having less than a hundred. The reviewer of such a review is hard put to it to know what to say: he cannot usefully deal with the literary merit of the articles, although there is an art in constructing such readable reviews as those on "Genetics of Micro-organisms" by O. Wyss and F. Haas, or on "Biological Nitrogen Fixation" by P. W. Wilson and R. H. Burris. He can prepare some interesting statistics from the size of the papers and their reference lists, or he can speculate on the editorial reasons for the order of the contributions in the book; but neither of these activities is very helpful to the case of incipient ulcer. Presumably the potential reader and purchaser wishes to know what branches of microbiology are covered, and to what extent this covering is competent, comprehensive and up to date.

In the field of microbiology, certain general aspects need to be reviewed each year. In particular, progress needs reporting in nutrition, metabolism

and in genetics; this year these subjects are in the capable hands of V. H. Cheldelin and T. E. King, E. R. and T. C. Stadtman, and Wyss and Haas, respectively. The article on metabolism is restricted to a comprehensive and instructive survey of publications dealing with fatty-acid, pyruvate, amino-acid and steroid metabolism. Shorter articles on specific aspects of microbial metabolism involve a reappraisal of nitrogen fixation and an account of food poisoning. Clinical and biological considerations concerning antibiotics are surveyed by F. R. Heilman, who includes a useful section on the growth and nutritional effects of antibiotics, while their large-scale production is discussed, together with that of many other industrial 'fermentation' products by A. Ledingham. Viruses form the subject of four contributions dealing specifically with developmental stages, biochemical aspects of growth, toxins, and the ecology of mosquito-borne viruses. Most authors have noted the latest date for which they have surveyed the literature, and this varies with different articles from December 1952 to February 1953.

The "Review" also provides surveys of developing fields; subjects dealt with this year for the first time in the series are 'Amœbiasis', medical mycology, and the metabolism, nutrition and chemotherapy of helminths. The range of modern microbiology is further emphasized by a paper, with 313 references, on the effect of adrenocortical hormones in infection and immunity. To this, F. Haurowitz adds another 252 references dealing with our understanding of the chemical basis of immunological phenomena. A collection of papers such as this is particularly valuable in that it emphasizes experiences in one field which may have repercussions in others; for example, several contributors refer to the effects that the increasing use of wide-spectrum antibiotics brings in its train, not the least of which is an apparent promotion of growth of pathogenic fungi.

One of the most stimulating, though alarming, consequences of reading this "Review" is the realization of the multitudinous unsolved problems in microbiology. H. E. Pearson stresses this feeling, at the end of his contribution on biochemical aspects of viral growth, by the words: "The principal need is to work, work, work". The average microbiologist may well feel that a collection of 3,504 references in a survey of one year of research presents work enough, and it is the existence of "Annual Reviews" such as this which makes it possible for him to direct his reading with optimal economic regard for his own original contributions in the future.

E. F. GALE

HANDBOOK OF THE PLANT ALKALOIDS

The Alkaloids

Chemistry and Physiology. Edited by R. H. F. Manske and H. L. Holmes. Vol. 2. Pp. viii + 587. (New York: Academic Press, Inc., 1952.) 14.50 dollars.

THE editors, contributors and publishers of this second volume on the plant alkaloids are to be warmly congratulated for fully maintaining the excellence of their first volume, which was published in 1950 (see *Nature*, 167, 48; 1951). In the preface to the latter, the editors set out their object—"to assemble in five volumes all the pertinent knowledge of the chemistry and pharmacology of the alkaloids". The reader of the first volume was not clearly informed how this aim in respect of the pharmacology was going to be attained, but in the preface to the second volume the editors announce that they "have been able to secure the cooperation of a number of competent pharmacologists to contribute chapters on a variety of physiological and pharmacological responses and these are scheduled to appear in Volume V".

In this second volume, the nine chapters are distributed as follows. The first and second chapters are on the morphine alkaloids (H. L. Holmes and, in part, G. Stork), the third chapter on sinomenine (H. L. Holmes), the fourth on colchicine (J. W. Cook and J. D. Loudon), the fifth on alkaloids of the Amaryllidaceae (J. W. Cook and J. D. Loudon), the sixth on acridine alkaloids (J. R. Price), the seventh on indole alkaloids (L. Marion), the eighth on the erythrina alkaloids (L. Marion), and the last chapter on strychnos alkaloids, Part 2 (H. L. Holmes).

These chapters maintain a remarkably high standard; they are comprehensive, readable and critical. They reveal many unsolved problems and for many a year should be an inspiration to professor and student alike. The constitution of morphine and its congeners has attracted more attention than that of any other alkaloid, and it is thought-arresting, if not provocative, to read that the structure of morphine has been established, except for the location of the ethanamine chain. An up-to-date discussion of the stereochemical arrangement of atoms in morphine and in strychnine is to be found in the appropriate chapters.

In the chapter on colchicine, the authors have dealt exhaustively with its chemistry and have then almost equally exhaustively dealt with the biological effects of this remarkable substance. In doing this they have presented an ideal example of the general aim of the editors discussed earlier; but it would, doubtless, be impracticable to extend this practice to every alkaloid even in a work of five volumes.

In reading through this volume, I was struck by the fact that many of the chapters could have been made more colourful by the freer mention in the text of the many assiduous and talented chemists who have contributed to the solution of what is so far known instead of the reader being confronted by a number, the key to which is found in the list of references at the end of the chapter. The student especially needs the name of the discoverer of any fact, either in the text or in a system of references at the foot of each page. On the system at present adopted the name of the discoverer of the golden nugget may be mentioned in the text, but the producers of the gold dust are hidden away at the end of the chapter.

Although an American publication, the reader would have to search hard to find evidence of such in the text of the chapters. To the British the spelling of "homolog" and "aluminum" are unusual, and the sentence "the hydroxyl group in the former occupies a different position than it does in the latter" is of a form not infrequently found in trans-Atlantic chemical literature.

The volume is remarkably free from errors. On p. 409 formulæ LXXVI and LXXVII are identical but purport to represent a base and its tetrahydro derivative, while on p. 420 there is a reference number 415*a* which is not included in the list of references at the end of the chapter.

HAROLD KING

PLANTS OF DOWNS AND DUNES

Downs and Dunes

Their Plant Life and its Environment. By Sir Edward Salisbury. Pp. xiii+328+32 plates. (London: G. Bell and Sons, Ltd., 1952.) 45*s*. net.

THIS book had its immediate origin in the lectures delivered by the author as the Fullerton professor at the Royal Institution, but it arises ultimately from the life-long experience of Sir Edward Salisbury as a field naturalist and his deep interest in living plants, whether in field or garden. Indeed, one of the great merits of the book lies in the wealth of original observations which it contains. This should be pointed out, since it may not be easily appreciated by the non-specialist reader that he is presented here with what is to a great extent an original work, containing the fruit of extensive first-hand observation in the field. Botanists who are ecologically minded (and who in these days is not ?) will be grateful for the material the author has provided for them. Sir Edward has always had the knack of publishing some of his most valuable research through unusual channels, and instead of spreading his information through a number of orthodox papers, as many others would have done, he has chosen to put it together in the form of a semi-popular book. If this leads the professed ecologist to overlook the book, it will be a pity, since he will find in it a great deal of material of the highest value to him. On the other hand, it will reach a larger public, and may open the eyes of interested country-lovers to the importance of detailed observation of the actual conditions of life among wild plants, and encourage them to undertake a wider kind of field-work than the 'naming' of plants, much of which can be carried out by any intelligent person, in which case the gain may be considerable.

The book refers, of course, to Britain, and the general outlook is, as we have noticed, ecological rather than systematic or geographical. In some respects it invites comparison with the recent publication by Lousley of "Flowers of the Chalk and Limestone"; but the bias of the two books is quite different, as the latter is mainly preoccupied with questions of floristics and distribution.

The association of downs and dunes together may strike the reader as an odd combination, and indeed, in spite of what the author claims in his preface, it is difficult to avoid the feeling that the link is primarily subjective. The two types of habitat share the qualities of having relatively dry, open, well-drained soils and, in part, the calcareous character; but the contrasts, both ecologically and floristically, are more impressive than the resemblances.

There is a substantial discussion of characteristic species, treating the plants of chalk grassland, calcareous beechwood, chalk scrub, chalk arable, limestone, yellow dunes, grey dunes and dune slacks as separate assemblages; but these chapters are called "Biological Notes", and they deal, not with taxonomic characters, which is the business of a Flora, but with the life-histories and environmental relationships of each species, information about which is often difficult to obtain and requires first-hand observation in the field. This was to be expected from one of the projectors of the "Biological Flora", which is slowly building up, species by species, in the hands of specialists, a body of the sort of information this book sets out to give in its more limited field.

Criticism of such a book as this is apt to take an individual form, since no two people would plan the work in the same way. Here and there, too, one may differ, though tentatively where so much is uncertain, from an opinion expressed. Viewed from a larger aspect, one regrets that no mention is made of chalk heath, that remarkable and fast-disappearing form of vegetation. The scrub lands of chalk and dunes are rather scantily treated, and more would have been acceptable on the beech itself. It has been expertly dealt with elsewhere, but in publications not so likely to be available to the general reader.

There is a most interesting and all too short chapter on gardening on calcareous soils, and one could have wished for similar enlightenment on seaside gardening.

The illustrations, drawings and photographs are excellent and nearly all are original. The photographs are admirably reproduced, and the type and format are very pleasant. The reviewer was delighted to see an acknowledgment to the late Prof. F. W. Oliver, to whose wisdom and deep knowledge of plants he, in common with the author, owes so much.

R. C. McLean

CHEMISTRY AND AGRICULTURE

Agricultural Chemistry

A Reference Text. By Prof. Donald E. H. Frear. Vol. 1: Principles of Agricultural Chemistry; pp. viii+812; (1950); 66*s*. net. Vol. 2: Practical Applications of Agricultural Chemistry; pp. viii+588; (1951); 71*s*. net. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd.)

YEAR-TO-YEAR fluctuations in regional harvests, dependent on chance climatic and other environmental conditions, cannot hide the fact that the general trend, in the more densely populated areas of the world, is for supplies of foods for human consumption to become less and less adequate to meet the needs of an ever-increasing population. It needs no seer to predict that, ruling out miracles, unless there occurs either the highly unlikely eventuality of a rapid and widespread reduction in birth-rate, or a great intensification of the application of modern agricultural science and technique to the world's cultivable acreage, a steady fall in the already meagre nutritional standards of perhaps two-thirds of the world's population, with increasing individual misery and growing social repercussions, is inevitable. Further, standards of living other than the nutritional are scarcely less related fundamentally to supplies of raw material of agricultural or forest origin. As the world's diminishing reserves of coal and oil approach exhaustion, supplies of raw materials for the manufacture of many industrial carbon compounds will have to be found elsewhere, and the strain on the areas used for food crops cannot fail to be further increased.

The many-sided applications of chemistry to the improvement of yield and quality of cultivated crops, if put into practice in time on a large enough scale

and in the right places, would certainly defer the onset of harder times and at least give a longer breathing-space during which it may be possible to avert calamity. The two large, and to the British purse rather expensive, volumes here under review deal in their fourteen hundred pages with a wide field not only of academic interest on its own account but also, for the reasons just given, of momentous significance for present and future human well-being.

"Agricultural Chemistry," says the editor, Prof. D. E. H. Frear, "embraces every phase of chemistry as it is related to the growing and processing of economic plants and animals." In Vol. 1, under the main heading "Some Fundamental Materials and Processes common to Plants and Animals", he has provided a series of useful introductory chapters on general biochemistry and followed this with more specialized sections, the first a group of contributions on aspects of plant biochemistry, the second a similar series of approaches to some of the main principles of animal biochemistry, and the third a short outline of soil chemistry. In the second volume, more especial attention is paid to the major agricultural products, to "fertilisers and soil amendments", to the nutrition of farm animals and to pesticides; there is also a chapter on inventions and patents relating to agricultural chemistry, and a final chapter on the increasing use of agricultural products and by-products as raw materials for the manufacture of industrially valuable products—raw materials which, unlike coal and oil, can be produced as rapidly as they are consumed.

Prof. Frear, who has written three of the forty-eight chapters, has had the assistance of no less than fifty-two other authors and must be congratulated on a great feat of editorship. As is inevitable, the different contributions vary somewhat in depth and in effectiveness, but the writers have been well chosen and evidently well briefed; the general level, especially in Vol. 1, is high, divergences from this standard are few and there is little overlapping. As a reference text for advanced and postgraduate students, the value of these volumes is increased by the addition, at the end of each chapter, of a bibliography of original papers and monographs for further reading; this value would have been increased further if some of the writers had ventured overseas for more of their references. Another slight blemish is that some of the informative tables, especially in Vol. 2, are printed from an unpleasing fount and have been needlessly reduced in size, making many of the individual numbers barely legible. The text itself, on the other hand, is excellently printed, clear and legible, and the binding above reproach.

As I have indicated, Prof. Frear has solved one major editorial problem. But another not less important problem from the point of view of the efficient provision of up-to-date text-books for post-graduate students must have been continuously before him and his publishers; while it is desirable from time to time to publish in one volume a new text dealing with the principles of an important scientific field such as, for example, general biochemistry, with which a large part of Vol. 1 is concerned, one wonders whether, as regards applications of those principles to widely varying agricultural or other industries, a more effective method than that adopted in Vol. 2 would not have been to publish an organized series of relatively short volumes each dealing with one aspect of the applied science. In some fields of applied agricultural chemistry advance is being made at astonishing speed; in others the pace is slower. One or two of the chapters in Vol. 2 are already 'dated', and it will not be long, say, three or four years, before they will require fairly extensive revision; others will need revision less frequently.

In the wide fields of chemistry and biochemistry applied to agriculture, the day of the comprehensive text must be almost over. The future must inevitably lie with a series of competent monographs, each brought up to date at such intervals as the progress in each specialist field demands. Such a series will, in fact, impose a smaller burden for a larger return, alike on the purse of the postgraduate specialist, on the capacity of his brief-case, and on the time and patience of the scientific editor of the series. This is not to say that Vol. 2, like Vol. 1, is not an excellent job; both volumes should be in every library dealing with agricultural science, with biochemistry, with applied chemistry, or with any aspect of food production or agricultural industry. H. D. KAY

GEOLOGY OF THE INDIAN SUB-CONTINENT

Geology of India

By D. N. Wadia. Third edition. Pp. xx+531. (London: Macmillan and Co., Ltd., 1953.) 50*s*. net.

THE third edition of this well-known text-book on the geology of India, Burma and Pakistan shows considerable changes from the second edition published in 1939. In that edition there appeared an appendix of sixty-one pages on the geology of Kashmir. This has now been eliminated, and its substance incorporated in the relative chapters, leading to a more balanced presentation of the geology of the sub-continent as a whole. Revision of some portions, addition of new material, and the use of larger type have increased the text from 443 to 514 pages. But by using thinner paper, this volume is actually slimmer than either of its predecessors.

A weakness of earlier editions was the inadequate treatment given to the Archæan rocks, occupying about three-fifths of peninsular India and providing much of the country's mineral wealth. In this edition some improvement has been effected by the addition of a few paragraphs to cover recent work; but the attention given to these rocks (no more than that devoted to the Pleistocene and Recent) is still inadequate, and the opportunity to re-write the section, and to correlate the very considerable advances made during the past twenty-five years, has been missed.

In dealing with the Gondwana System, the author still retains the three-fold division of the previous editions, as opposed to the more logical two-fold division adopted by the Geological Survey of India and by the late Sir Edwin Pascoe in his comprehensive third edition of the "Manual of the Geology of India". No doubt it would be awkward to make so abrupt a change from previous editions; but the relative merits of the two classifications, with a discussion of the principles involved, might well have received some attention. In the chapters on the Tertiary rocks, perhaps the best part of the book, some minor

revision has been introduced, largely the result of recent work by the Assam Oil Company.

As in previous editions, the stratigraphical sections are followed by chapters on the physiography and on the economic geology of the country, thus affording the student a complete account of Indian geology; while a coloured geological map on the scale of 96 miles to 1 in. is given in a pocket at the end. Prepared by the Geological Survey of India in 1949, it is an up-to-date map in which separate colour indexes have been used for the peninsular and extra-peninsular regions.

The Indian sub-continent provides a fine example of a stable continental shield lying adjacent to one of the earth's great mobile belts, with the attendant problems of crustal structure, gravity anomalies and earthquake phenomena. It is the birthplace of the hypothesis of isostasy, of the theory of earthquake wave motion, and of the conception of a great southern continent, Gondwanaland, with its *Glossopteris* flora; also, the Siwalik hills bordering the Himalaya were the home of a rich mammalian fauna, the fossils of which adorn the museums of the world. All these matters receive adequate attention (within the compass of a text-book) in this volume. Written in a fluent style, it has been an inspiration to generations of Indian students, and a standard work consulted by foreign geologists. In this latest edition the publishers have produced a well-printed volume; but it is unfortunate that the price has been doubled, for it must now be beyond the reach of many who would wish to own it.

W. D. West

BEE BEHAVIOUR

The Behaviour and Social Life of Honeybees

By C. R. Ribbands. Pp. 352+9 plates. (London: Bee Research Association, Ltd., 1953.) 21*s*.

AMONG the social insects only the bees, and in particular *Apis mellifera*, have come into close contact with man; and while man's primary interests were honey and wax and nowadays extend to pollination, the doings of the bees have since time immemorial attracted curiosity and imagination.

Mr. C. R. Ribbands is almost entirely concerned with facts, and consequently the chapters of his book lead the reader from the origins of scientific observation through the past hundred and eighty years to the latest stage of each problem in our experimental era. In collecting his information from many languages and blending it with his own experiences, he has written a well-balanced book which by its simplicity of language, beauty of photographs and many diagrams is a joy to read.

The book has four sections, the first of which deals with the roots of behaviour (sense perception, glandular development and caste differences) and is followed by a section on the individual behaviour in the field (flying, foraging, mating, time sense, etc.). The third section deals with communication between the bees (recruitment to crops, selection of a home, recognition of companions and defence of the community), and this part also contains a practically interesting discussion of the methods for directing bees to particular crops. The fourth section—the longest—describes food sharing, clustering, building and brood-rearing, as well as those activities which are concerned in the propagation of the individual and the colony. Its main conclusion is that the evolution of the social insects can be understood in terms of a series of adaptive responses to food supplies and that the honey bee, in particular, owes much to the habit of food sharing; parts of this discussion are polemical and will perhaps not be generally accepted.

The book, primarily written for students of bee behaviour, will nevertheless be appreciated by many people interested in certain wider aspects of comparative physiology, communication and group behaviour. This may be illustrated by the discussion of a few topics. Von Frisch, utilizing the social habit of foraging, showed several years ago that bees can orientate themselves in relation to polarized light; since then this faculty has been discovered in many solitary insects and crustaceans which do not collect food and are thus more difficult to train. Thus a faculty which is probably common to all arthropods having compound eyes has been discovered by its attachment—in the course of evolution—to more complex patterns of behaviour.

The astonishing fact, that worker bees can be directed to a crop by another bee's dancing, is also based on simpler potentialities of wide occurrence. It is perhaps easiest understood as an imitation by the recruited bees of the intentional movements of the discoverer of a new source of food (that is, its dance), before it flies out again. In this dance four features of orientational value are incorporated, namely, the odour, abundance, distance and direction of the crop. The odour is simply that of the nectar or pollen, clinging to the body of the dancer; the abundance of food is indicated by the duration of the dance, which one may take to be proportional to some sort of 'excitement'; while the distance of the crop, expressed by the frequency and duration of tail-waggling, similarly indicates the anticipated 'effort' for the next foray. The last feature in this 'language without words', namely, the expression of direction, is based on an equivalence of geotropism and phototropism, common among plants, animals and man: a bee dancing on a vertical comb deviates by the same angle from the zenith as the direction of its horizontal flight to the crop deviates from the direction of the sun; this rather reminds one of the convention that 'up' in a map indicates north, or the fact that twelve o'clock on the dial of a clock points upwards.

Communication of all this information is effected when an unemployed worker on the comb, alerted by the dancer, imitates the peculiarities of the former's dancing movements and then leaves the hive to search for the crop.

Students of group behaviour will perhaps find a description of observations by Lindauer of even greater interest. This concerns what can only be called communal decisions by swarming bees. A figure summarizing five days of observations on a cluster indicates how scouts flew out in various directions and how each on its return danced in the direction which it had found suitable for a new home. Sometimes one party grew stronger, and sometimes another. But only after all dancers pointed in the same direction did the swarm finally take off.

Observations like these seem to hold some promise of further discoveries, and the first step towards making them might be to read Mr. Ribbands's book.

H. Kalmus

Recent Developments in Mineral Dressing

A Symposium arranged by the Institution of Mining and Metallurgy, held on 23rd–25th September, 1952, at the Huxley Building, Imperial College of Science and Technology, London. Pp. xxviii+766+36 plates. (London: Institution of Mining and Metallurgy, 1953.) 60*s*. (30*s*. to members); 8.50 dollars.

THIS volume brings together the thirty-nine papers, together with their discussions, which were presented in the symposium on this subject held in London during September 1952. It also contains the Wernher Memorial Lecture by Prof. A. M. Gaudin on "Radioactivity in Mineral Dressing". The more important aspects and technologies of this basic industry are covered expertly in these papers, which provide a rich mine of information not only for the technician in charge of such ore treatment in the field, but also for the research worker. In any presentation of mineral dressing, a subject which is still consolidating itself on a scientific basis, the reader may be somewhat disconcerted by the wide range of topics treated and the various levels at which these treatments are presented. Such catholicity is inevitable in the presentation of the variety of processing methods applied to the low-grade ores which supply the bulk of the world demand for engineering metals, rare earths, phosphates, diamonds and bullion, to name some of the main industrial products.

Some of the papers deal with laboratory methods developed in research on sub-sieve sizing, particle dynamics in simple and accelerated fields of gravity, electrostatics, and with considerations of lattice structure, surface chemistry and physics, and hydrometallurgy. Other papers discuss commercial application and relate it to laboratory controls and their underlying principles. The scientist or practising engineer whose work calls for understanding of the behaviour of insoluble particles at all sizes down to a few microns will find much of interest in this symposium. A good index is provided, and the plates and diagrams are clear and informative.

E. J. PRYOR

Radioisotopes in Industry

Edited by John R. Bradford. Pp. viii+309 (15 plates). (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 64*s*. net.

THE uses of radioisotopes to industry are now acknowledged, and this book is a collection of papers read at a symposium at the Case Institute of Technology, Cleveland, Ohio, in 1951. The fourteen chapters are all by different authors, many of whom have first-hand knowledge in this field. Six chapters describe the uses of isotopes in chemistry and industry, three are on laboratory design and isotope handling and two on health physics. There are also two appendixes of useful pile-made and cyclotron-made radioisotopes.

The papers are printed in the same form as presented at the conference. This unfortunately makes the book in many places repetitious, while at the same time some important subjects that would interest the industrial user are left out. For example, the principles of radioactive tracer dilution are explained by four separate authors, while there are six references to gamma radiography in all cases without details or critical assessment of the method. On pp. 25 and 97 will be found the same drawing and caption to illustrate measurement of piston and cylinder wear. The reader is given no guidance on any of the methods of radiation detection. Something about beta- and gamma-ray counters, ionization chambers and scintillation detectors could well have been included. In the preface the editor states it is his aim to include new developments since the conference. There is no evidence of this in the text, and the bibliography does not list anything later than 1951. Several misprints exist that should have been corrected.

In spite of these shortcomings, a number of the papers are useful and informative to the industrial user, and references for wider reading are given. The book is illustrated by many drawings and also photographs of work in the United States in the Atomic Energy Commission's laboratories; it is stoutly bound and suitable for hard wear.

W. S. EASTWOOD

Atoms and Energy

By Prof. H. S. W. Massey. (Science in Action, 1.) Pp. 174. (London: Elek Books, Ltd., 1953.) 16*s*. net.

THIS is a popular account of the present state of nuclear physics, written with a genuinely scientific outlook. Drawing on the reader's knowledge of everyday mechanical effects and chemical actions, Prof. H. S. W. Massey explains the general principles underlying the release of nuclear energy in simple and non-technical language. From the discussion in the first chapter of the nature of the forces between nucleons to the concluding account of the numerous particles disclosed in recent cosmic-ray research, the line of thought is clear. Here are certain fundamental principles, some well established and some as yet imperfectly understood, which form the framework within which the nuclear physicist must of necessity work.

The great ion-accelerating devices are explained in principle rather than in detail, and the reader is told fully why they are used, and what they have so far revealed of the nature of nuclear forces. The many practical applications of nuclear energy, and its possibilities in the service of man, are discussed deeply enough to give a good general outline of the present position. Where matters outside the field of pure science are involved, the author presents the scientist's own point of view clearly and with vigour.

The book can be recommended as a useful guide for the general reader, chiefly because it goes so far to meet him on his own ground. Every educated citizen must be interested in the general trend of ideas in nuclear physics, and in the way they may ultimately react on his own way of thinking and his daily life; and both are explained clearly here. Little is said about the purely technical side, which such a reader will be only too glad to take for granted.

G. R. NOAKES

Possums

By Carl G. Hartman. Pp. xiii+174. (Austin: University of Texas Press; London and Edinburgh: Thomas Nelson and Sons, Ltd., 1952.) 30*s*. net.

THIS splendid book epitomizes all that is known about the life and history of the American opossum. Beautifully written by the man who knows more about the opossum than anyone else, it is objectively scientific but enriched with a dry humour and directness of style that make it as fascinating to the layman as to the zoologist who specializes in mammals. Dr. C. G. Hartman discusses

the history of the opossum since the first settlers in America brought it to the knowledge of Europe, and devotes a chapter to the marsupials of Australia. Other matters dealt with include the opossum in legend and folk-lore, "playing 'possum", prehensile tails, farmyard depredations of the opossum, the fur trade, 'possum hunting, and recipes for cooking "possum and taters".

But it is the account of the embryology of the opossum and the birth and early life of the pouch embryos that makes the outstanding part of the book, and forms a permanent monument to Dr. Hartman's pioneer researches extending over forty years. He was the first to work out and record in detail the extraordinary history of the opossum egg which seems so reluctant to fulfil its destiny. With only thirteen days of gestation available between mating and birth, it dawdles through the first stages of development, making little apparent progress; there is "only a tiny rudiment of the embryo present although half the intra-uterine life has already passed. . . . The transition from delicate vesicle smaller than a pinhead to newborn opossum requires only six days". The photographs illustrating this process are unsurpassed.

This book is natural history as it should be, a combination of field work, laboratory study and literary research that will win Dr. Hartman the admiration of a host of new friends and the hearty congratulations of his many old ones.

L. Harrison Matthews

A Provisional Check-List of the Butterflies of the Ethiopian Region

By Dr. Wallace Peters. Pp. 201. (Feltham: E. W. Classey, 1952.) 45*s*.

A CHECK-LIST of any group of animals is always a valuable working tool for the student of the group, whether he is a dilettante or earnest collector, a museum curator or taxonomist; to the ecologist and sometimes the physiologist it is a warning, not always heeded. The butterflies of Africa during the past half-century have provided a tremendous field for the development of Darwinian theories of evolution, especially along Poultonian mimicry lines, and a very extensive literature now exists, based on the observations of a numerous band of field naturalists. These naturalists would be horrified to find that there now exist about a hundred and twenty named varieties of *Papilio dardanus*, very few of which have so far been in any way correlated with what is known of the genetics of this astonishing butterfly. The *mihi* cult dies hard among amateur lepidopterists. The author has performed a useful service quite well in bringing together in orderly fashion this index to the scattered and unequal writings of others. This orderliness, however, is often more apparent than real, for there are many fascinating taxonomic problems yet to be unravelled among the butterflies of Africa before a check-list free of pitfalls can be produced. The present one reflects almost too truthfully these inequalities in our knowledge, especially in the Lycaenidae, where, to take only one example, part of Group 1 of the genus *Pentila* (p. 92) is repeated as the genus *Liptenara* on p. 97. Many species are misplaced; yet as only a specialist would know this, the author is perhaps scarcely to blame, for the work is admittedly a compilation. The confusion is no greater than that which reigns in most collections of these insects. The book is well printed, with plenty of room for corrections—it is not free of misprints and omissions by any means—but it is a little irritating to find the names of so many well-known authors abbreviated in quite novel forms; and it seems a great pity to have wasted one-quarter of the whole on two separate and very elaborate indexes when one plain index is all that is needed.

N. D. Riley

Freshwater and Salt-water Aquaria

By Sir Francis G. W. Knowles, Bt. Pp. 174+11 plates. (London: George G. Harrap and Co., Ltd., 1953.) 12*s*. 6*d*. net.

THOUSANDS of people keep an aquarium, both naturalists who delight in the minute observation of the inmates' habits and "those to whom an aquarium is a decorative and amusing piece of furniture for the living room". No laboratory where biology is taught is complete without a battery of aquaria. The author hopes that this book will serve as a guide for the beginner, and a reference work for the accomplished aquarist; his hope should be fulfilled. He first discusses in simple terms the basic principles of successful aquarium-keeping, and then gives clear directions for setting up and stocking both freshwater and marine tanks. But he does more than this, for he gives a large amount of sound biological information about the plants and animals suitable for life in captivity. The chapter on diseases and difficulties, based upon personal experience, will be of special value to the newcomer to the fascinating pursuit of aquarium-keeping.

The book is well illustrated with drawings in the text and good photographs; there is a short bibliography, and a full index.

Sotheran's Bibliotheca Chemico-Mathematica

Catalogue of Works in Many Tongues on Exact and Applied Science. Third Supplement. Pp. viii+442. (London: Henry Sotheran, Ltd., 1952.) 42*s*. net.

THE third supplement to Messrs. Sotheran's "Bibliotheca Chemico-Mathematica" is made up of this firm's priced catalogues Nos. 875, 877, 879, 884 and 896, issued between 1946 and 1952. These have been bound together in one volume, in red buckram, to match the previous volumes in the series. Together, these catalogues cover a wide field in pure and applied science, including the various branches of mathematics, astronomy, physics, chemistry, engineering and geology (but excluding zoology, botany and other biological sciences). The pagination is continuous, and 5,951 items are listed and described. Thus, the new supplement by itself forms a useful work of reference. While, inevitably, there is considerable duplication in the entries, when compared with those contained in the earlier parts of the "Bibliotheca", the compiler, Mr. H. Zeitlinger, states that there are also many not previously recorded. It should therefore be worth while for owners of the previous volumes of the "Bibliotheca" to acquire this supplement, in which the listed works are bibliographically described and annotated by Mr. Zeitlinger, with his usual scholarly care. The prices now asked for the older scientific books of historic interest reflect the fact that, as has become apparent during recent years, there is an increased demand and growing scarcity of such works. This is a publication which, like its predecessors, can be recommended with confidence as a valuable tool for librarians, historians of science and book collectors.

THE GEOGRAPHICAL ASSOCIATION

By Dr. W. G. V. BALCHIN
King's College, University of London

THE annual conference of the Geographical Association recently held at the London School of Economics terminated an eventful year in the history of the society. A diamond jubilee can only occur once, and due note of this important stage has underlain the activities of the Association during the past year. The work of the past sixty years has contributed greatly to the recognition of geography as an academic subject, and a brief survey reveals the transformation which has taken place in this space of time.

During the early and middle part of the nineteenth century, geography was a much neglected subject in Great Britain, despite the great advances which had been made in the realm of exploration and discovery, and in the field of physical geography: and despite, too, the work of Humboldt and Ritter on the Continent, and of Mary Somerville and the activities of the Royal Geographical Society (founded 1830) in Great Britain. The subject was practically non-existent in the universities; no professor in geography existed at either Oxford or Cambridge, although questions on 'mathematical geography' (largely astronomy) were set in the Mathematical Honours examinations. Oxford also had for some time an optional paper in geography at pass-degree level, but this was linked to history. It is true that professors of geography existed for short periods at University College, London (1835–37), and at King's College, London (1863–76), but little is known of their activities while holding office. In the public and grammar schools of Britain, the education provided was almost wholly classical, and geography was restricted to the Mediterranean—and junior classes. The elementary schools had little time for anything but the three *R*'s. The status of the subject was undoubtedly very low, and it was probably very badly taught. But in the new training colleges for teachers, geography was given some prominence, and in time the subject began to appear in the newly established middle-class schools. By the 1880's it was being offered by candidates in the Cambridge Local examinations.

Somewhat paradoxically, the same period saw a further decline at higher levels, and this led the Royal Geographical Society to take an active interest. In 1869, largely through Francis Galton, prize medals were offered for competition in the public schools; but this did not prove very successful and the scheme was dropped in 1884. By this time Galton had been joined at the Royal Geographical Society by James Bryce, Douglas Freshfield and H. W. Bates, and these four were largely responsible for the appointment of (Sir) John Scott Keltie as an inspector, in 1884, to make an extensive inquiry into the teaching of geography in Great Britain and America and throughout the Continent. Keltie's report was issued in 1886, and his collection of books and apparatus was exhibited all over the country and stimulated much interest. At the same time, renewed efforts were made to induce the Universities of Oxford and Cambridge to provide lecturers in geography: in this the Society was successful, although at the cost of finding half the salaries. The Oxford appointment was a brilliant success, for in 1887 (Sir) Halford J. Mackinder took up his duties as reader in geography, after having made a name for himself as a University extension lecturer.

Meanwhile, B. B. Dickinson had developed an interest in the subject quite independently and was trying it out with the boys at Rugby School. The scene was now all set for the founding of the Geographical Association, for Dickinson was interested in the "new fangled magic lantern" as an aid to teaching, and he conceived the idea of an exchange system for lantern slides. Discussions with Mackinder and the Royal Geographical Society followed, and as a result a letter was circulated to public schoolmasters in April of 1893 inviting them to a meeting in Oxford. The letter was signed by B. B. Dickinson of Rugby; D. Freshfield of the Royal Geographical Society; H. J. Mackinder, reader in geography at Oxford; T. Field, headmaster of the King's School, Canterbury; and C. E. B. Hewitt of Marlborough. Although originally called to formulate a scheme for the exchange of lantern slides, the discussion on May 20 led on to the idea of an association, and at a further meeting on August 3, 1893, the Geographical Association emerged "in order to improve the status and teaching of Geography in Schools", and B. B. Dickinson (somewhat to his surprise, we gather) found himself the first secretary.

The work which had previously been carried out *inter alia* and somewhat intermittently by the Royal Geographical Society was now taken up wholeheartedly by the new organization, and both the Association and the study of geography have advanced in strength with each passing decade. A membership of a mere handful has now grown to nearly 3,500, and what was once a dull neglected subject in the schools has now become a vigorous, popular and interesting, and well-established study.

In most public schools a large number (often more than half) of the pupils now prepare for the Geography papers of the General Certificate of Education (Ordinary Level) Examination. An even greater number take geography in the grammar schools, where the subject now ranks fourth in importance after English, French and Mathematics, and more than 75 per cent of the pupils present geography for examination at the Ordinary level. In the Higher level examination, an increasing number of candidates present themselves yearly—in the London examination the numbers have more than doubled since before the Second World War and one advanced level candidate in every five now takes geography. In the universities, too, geography is now a well-established discipline—no less than twenty-seven chairs of geography have now been created and more than 175 lecturers and assistant lecturers are to be found in the universities of the United Kingdom. No major institution is, in fact, without a fully staffed and adequately maintained department of geography. The contrast is indeed startling, and the Geographical Association can look back with pride to the part it has played in bringing this about.

The Association has in its time had the support and active interest of many influential personalities:

in the early days, the president's office was filled by such well-known figures as Sir Halford Mackinder, Douglas Freshfield, Prof. E. J. Garwood, Sir John Scott Keltie, Hilaire Belloc, Prof. Gilbert Murray, Viscount Cecil, Sir John Russell, Sir Richard Gregory, Sir John Myres, Dr. H. R. Mill, Lord Meston and Lord Stamp; while in more recent years Sir Patrick Abercrombie, Sir Cyril Norwood, Sir Alexander Carr-Saunders, Sir Harry Lindsay, and Profs. H. J. Fleure, L. Dudley Stamp and F. Debenham have officiated. The vital post of secretary passed from B. B. Dickinson to Prof. A. J. Herbertson in 1900, who later had the assistance of Prof. J. F. Unstead. In 1917 Prof. H. J. Fleure became secretary, and for thirty years until 1947 he successfully guided the Association through contrasting phases of difficulty and prosperity. Among geographers, too, the work of Leonard Brooks, C. C. Carter, James Fairgrieve, J. S. Masterman, P. M. Roxby and T. C. Warrington for the Association will not be forgotten.

The aim of the Association "to improve the status and teaching of Geography" has involved it in a great variety of activities. These range from the maintenance of a well-stocked lending library of books and lantern slides at the headquarters in Sheffield, and the publication of a quarterly magazine *Geography* (formerly called *The Geographical Teacher*), to the holding of conferences in the Christmas and Easter vacations and summer schools in the long vacation. Active standing committees deal with geographical matters appertaining to the public and preparatory, and primary and secondary schools. Other committees exist for the teacher-training colleges and further education, while some fifty branches covering the United Kingdom arrange local lecture and excursion programmes. The Association publishes books and reports relating to geography in the schools and its teaching, and it has conducted many inquiries into examinations and syllabuses. It has worked ardently for special classrooms in schools for geography, encouraged visual aids and assisted the B.B.C. in the broadcasts to schools.

The Association has further fostered the founding and encouraged the growth of the Ship Adoption Society, the Council for the Promotion of Field Studies, and probably most notable of all the Land Utilization Survey. The latter project began with the work of Messrs. J. Fairgrieve, E. E. Field and J. L. Holland: this led to the creation of a standing committee of the Association to deal with land-use mapping. The chairman was Prof. L. Dudley Stamp, who eventually carried the work, by means of the independent Land Utilization Survey, to such a brilliant conclusion. The Geographical Association has also had close and friendly relations throughout its growth with the Ordnance Survey, the Royal Geographical Society, the British Association for the Advancement of Science, the Le Play Society and the Institute of British Geographers (which emerged in the 1930's as a result of the growth of university staffs).

For many members of the Geographical Association the annual conference has become one of the more important events in their geographical calendar. This has been held for many years past in the London School of Economics during the Christmas vacation, and the conference which has just concluded, organized by Dr. W. G. V. Balchin, proved to be one of the most successful and largest yet: nearly four hundred teachers and intending teachers of geography attended the various lectures, exhibitions and excursions arranged for them between December 30, 1953, and January 2, 1954.

In his presidential address to the Association, Dr. O. J. R. Howarth put forward a plea for the greater prominence of Commonwealth studies in the normal geographical syllabus as an intermediate and essential step to a full recognition of world citizenship. The Commonwealth was also the underlying theme of an extensive exhibition organized to show the teacher the range of visual aids now available to assist him in this task. The wide and varied field of interest covered by matters geographical was illustrated by lectures on the work of the Nature Conservancy by Captain Cyril Diver, on recent exploration in the polar regions by Mr. A. Stephenson, and on land and population problems in British Tropical Africa by Mr. R. W. Steel.

As was to be expected, educational aspects figured conspicuously in the proceedings: symposia were arranged on the place and use of Ordnance Survey maps in the primary school, on problems in using visual aids, on geography in further education, and also on specialization in sixth forms—which it was unanimously agreed should be strongly resisted. In addition, Mr. J. B. Goodson discussed sketch maps in the teaching of geography, and Mr. R. C. Honeybone lectured on balance in geography and education. A selection of recent geographical films was shown, including some excellent Kodachrome colour films of field work in Cornwall presented by Prof. P. W. Bryan. On Friday, January 1, the Association joined forces with the Institute of British Geographers and the Royal Geographical Society for the customary annual joint meeting at the Royal Geographical Society. On this occasion the subject could be none other than Everest, and a large audience heard Mr. T. D. Bourdillon and Mr. C. W. F. Noyce lecture on the ascent of 1953 and its significance.

Two popular features of recent conferences again figured prominently in this year's proceedings. A publishers' exhibition of books, maps and appliances for the study and teaching of geography was arranged and more than fifty publishers participated. The founders of the Association would indeed have been surprised, but no doubt extremely gratified, could they have seen the extensive and varied display of geographical material now available. Secondly, the conference was brought to a successful conclusion by an interesting series of excursions: conducted visits were paid to the Map Room of the British Museum, the Central Forecasting Office of the Meteorological Office at Dunstable, and the Port of London; while field work was undertaken in Kent under the direction of Prof. S. W. Wooldridge and Dr. O. J. R. Howarth.

COLOUR-RENDERING PROPERTIES OF FLUORESCENT LAMPS

THE phenomena and problems of colour rendering are by no means new. One need only instance the false values often introduced by faulty photographic technique, the strange make-ups necessary for the stage or in front of the ciné and television cameras, or, even commoner experience, the cheerfulness of the bright colours of a sunny day contrasted with the gloomy dullness produced by a heavily overcast sky. The sudden widespread use of fluores-

cent lamps, however, has placed a new emphasis on colour rendering, and the symposium organized by the Colour Group of the Physical Society on December 9 was an endeavour to gather and summarize present work on the subject in Great Britain.

According to experiments mentioned by J. M. Waldram in the discussion (unfortunately never published), the assessment of the colour-rendering properties of a lighting installation depends very largely upon what the observer was looking at immediately beforehand. In many cases it was found possible to reverse a decision by suitable pre-adaptation. For example, an observer, having been for some time in a room illuminated by true daylight, found the colour rendering objectionable on going into a room illuminated by fluorescent 'daylight'; but when first adapted to fluorescent 'daylight', he found true daylight objectionable. Such observations clearly divide the colour-rendering problem into two parts: (*a*) a more-or-less sudden change from one illuminant to another produces responses from observers which may be ephemeral, or even reversible; (*b*) if the change is large enough, the observers' responses will be permanent (for example, a plain low-pressure mercury lamp is so deficient in red that no normal observer ever accepts it as satisfactory). The avoidance of complaints of class (*a*) is a matter of illuminating installation and design; but complaints of class (*b*) bring one to the heart of the problem, namely, the determination of what might be called an absolute threshold of change in colour rendering.

Ever since fluorescent lamps were produced commercially, attempts have been made to describe them so that their colour-rendering properties might be apparent. Both Miss B. M. Young and G. T. Winch ("Binocular Viewing Investigations") and Dr. S. T. Henderson and D. T. Waigh ("A Critical Review of Colour-Rendering Problems") set forth these attempts in some detail. Broadly speaking, three types of description have been proposed: (*a*) the complete spectral energy curve, with some convention as to representation of energy in spectral lines; (*b*) a system of spectral bands, the data being the relative energy or luminance in each band; and (*c*) a single figure of merit. The single figure of merit, proposed by some workers in the United States, is worked out on so arbitrary a basis that it may prove very misleading unless its application is severely limited. Systems of spectral bands, the number of bands varying from five to sixteen or so, have been proposed by many workers, and a specification of this sort appears the most promising, striking as it does a happy mean between the complexities of the complete spectral energy curve and the over-simplification of the figure of merit. In passing, mention may be made of the red index favoured by Henderson and Waigh. As its name implies, the red index of a lamp gives on an arbitrary scale the proportion of red light in the total visible radiation; but this, like the figure of merit, is such a limited description of a lamp that it scarcely helps in the general solution of the problem.

Whatever type of description is eventually adopted, its curves or figures must be provided with upper and lower limits between which the characteristics of all lamps of a given class must lie. A distinction is to be made here between the relatively small manufacturing tolerances between one lamp and another of the same type, and the much larger tolerances between different types of lamp belonging to the same class, for example, the class of daylight lamps. It is these latter tolerances which are the concern of the colour-rendering investigator, and which Winch and Young at the Research Laboratories of the General Electric Co., Ltd., and Crawford at the National Physical Laboratory are endeavouring to determine experimentally.

The method of Winch and Young (described fully in the *G.E.C. Journal*, **19**, No. 4; 1952) is an adaptation of the binocular matching technique used by W. D. Wright ("Researches on Normal and Defective Colour Vision", Kimpton, 1946), R. W. G. Hunt (*J. Opt. Soc. Amer.*, **40**, 362; 1950) and others. Very briefly, their method is as follows. The two eyes of an observer view two fields identical in pattern and intrinsic colour, but differing in colour of illumination. For example, one field may be illuminated by north-sky light, the other by a fluorescent 'daylight' lamp. Each field has at its centre one of a pair of identical coloured test panels. On first looking at the fields, the two eyes of the observer will, in general, perceive different colours in both surround and test panel, but after some minutes the fields will tend towards the same appearance owing to adaptation of the observer's eyes. Any residual difference between the test panels is compensated by addition of an adjustable red–green–blue mixture to the illumination of one of them (but not to the surround). This addition is a direct measure, under the conditions of the experiment, of the change in appearance of the test colour due to the given change in illumination. Such measurements have been carried out in great number and variety by Winch and Young, and there is no doubt of the value of the method in the ease and precision with which it can map out changes in colour appearance for different conditions and for a number of observers. Unfortunately, the method still leaves uncertain the exact tolerances on energy distribution which are applicable to any particular case.

The work now in progress at the National Physical Laboratory is designed as a direct attack on the problem of tolerance determination, and was described by Dr. B. H. Crawford in the third contribution to the symposium ("A Logical Method of Investigating Colour Rendering"). In the first place, a light source has been set up in the form of a very large double monochromator of the type which recombines at the exit slit the light dispersed in the central spectrum. The emergent light can thus be completely controlled in spectral composition by shutters and diaphragms placed in the plane of the central spectrum, and can be used for illuminating pictures, patterns, or objects to be viewed by the subject of the experiment.

The general method of experiment has been designed for the determination of the absolute thresholds of change in colour rendering discussed above in connexion with the work of Waldram and his colleagues. By means of mechanically moving shutters in the central spectrum, the emergent light is changed in composition so slowly that the adaptation of the observer's eyes is in a sensibly steady state the whole time; and when he signals that a definite change, either specified or general, has come over the pattern he is viewing, he has made a determination of threshold change in colour rendering which approximates closely to the ideal specified above. The threshold thus determined is, in fact, a tolerance, and when such thresholds or tolerances have been determined for a sufficient variety of objects and observers, it should be possible to propose

tolerances for the figures which describe a lamp of any particular class.

Some preliminary results were described by Crawford on the basis of a division of the spectrum into six bands. As the tolerance for any one band was of the order of 50 per cent, it is clear that any considerably larger number of bands would be futile from the point of view of colour rendering. These six bands are not regarded as a final choice: further work should enable them to be modified so as to give each one an approximately equal weight in, say, the assessment of mean daylight. But there are certain features which any system of bands should have if it is to be acceptable from the colour-rendering aspect, namely, divisions where blue changes to green and green to red, giving three fundamental bands, and equal subdivision of these three, so that the final number of bands would be three, six or nine. Considerable importance has been attached in the past to avoiding coincidence between mercury lines and divisions between bands; but this can be easily attained by very small wave-length shifts once the bands most suitable for colour-rendering specification have been determined. B. H. Crawford

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SPOILAGE OF INDUSTRIAL MATERIALS BY MICRO-ORGANISMS

A VAST amount of spoilage of the perishable materials fabricated or harvested and used or stored by man is brought about by micro-organisms. Incalculable losses are incurred by the rotting of textile fabrics and paper, the making unpalatable of food and feeding-stuff and the decay of wooden structures, quite apart from the less vital but none the less economically important 'mildewing' of these and other organic materials. These matters were discussed at the autumn meeting of the Society for Applied Bacteriology, which was held in London at the Royal Society for Tropical Medicine and Hygiene on October 20, 1953, and which took the form of a symposium on "Microbial Spoilage in Industrial Materials".

In an introduction to the symposium, Dr. T. Richards (Reading) pointed out that the spoilage organisms belong almost entirely to the two groups, bacteria and moulds. Their deleterious effect is due to actual destruction of the material as in rotting, or to the development of unsightly microbial growths, or the production of toxic or offensive metabolic products. Dr. Richards surveyed the principles governing the growth of micro-organisms, since a knowledge of these provides a means of restricting microbial proliferation and consequent spoilage.

Only materials having an available carbon source together with a nitrogenous and mineral salts supply are susceptible to spoilage. Atmospheric ammonia can supply available nitrogen to an otherwise nitrogen-free material. Limiting the supply of nitrogen or mineral salts exercises a marked preservative effect in carbohydrate materials.

Control of moisture offers the most widely applicable means of restricting microbial growth. Atmospheric humidity is the critical factor, and to limit mould growth for storage periods of several years the relative humidity of the storage atmosphere must be less than 65 per cent, although at 72–73 per cent no mould growth may be noted for several months. The same concept of relative humidity is useful in assessing the preservative value of strong solutions of sugar or salt. In solutions the vapour pressure of which can be equilibrated with relative humidities of about 72 per cent, yeast growth and mould growth are inhibited. Many moulds are inhibited at humidities less than 90 per cent, and, apart from micrococci and possibly *Pseudomonas*, bacteria seem to require conditions approaching actual wetness.

Hydrogen ion concentration is a factor of importance in preventing spoilage, especially in combination with anaerobiosis, although these applications are of necessity largely confined to food and fodder. Bacteria are all inhibited at about *p*H 4, save for a few aerobes, and in the absence of air these and all aciduric moulds cannot grow. Yeasts can only proliferate in the limited cases where there is a fermentable carbohydrate.

Low temperatures are of much greater general application in preventing microbial spoilage. 'Chilling' processes, from 0° C. to about 6° C., are successful over short storage periods and with lightly infected material, although preservation over an indefinite period is possible at the −20° C. or so of modern deep-freeze technique. Lack of oxygen, already mentioned, has no preservative effect *per se*, but in acid or low-moisture conditions it becomes a decisive factor in the inhibition of aciduric and xerophilic moulds.

Much could be said concerning the use of specific antimicrobial agents, antiseptics, fungistatics, etc.; but rightly these should be depended upon only when the fundamental necessities of microbial growth cannot be eliminated. In general, where deep refrigeration is impossible, impracticable or uneconomic, one must rely on low *p*H and anaerobiosis, or upon storage in an atmosphere of low relative humidity. Failing these, resort must be made to antiseptic substances, but this is advisedly a last resort: there is no ideal antiseptic, no rules govern their use, their mode of action is obscure, and in many cases tolerance is readily acquired. Some such agents have been successfully used, and examples were given in the symposium by ensuing speakers.

The problems of wood spoilage were dealt with by Mr. J. G. Savory (Princes Risborough), who emphasized the huge bill of damage caused by one species of wood-rotting fungus alone—the true 'dry-rot'. Quite apart from the structural damage due to rotting, much spoilage arises from the fungal discolorations. The so-called 'blue-stain fungi', all Ascomycetes or Fungi Imperfecti, have brown mycelium but stain the wood blue or grey. These organisms do not attack cellulose or lignin, but utilize the starches and sugars in the sapwood.

Basidiomycetes cause the brown and the white rots of timber. Brown rot fungi attack the wood cellulose leaving the lignin, and as the attacked wood dries out the characteristic cubical fracture is seen. The white rot fungi have an oxidase system and attack both lignin and cellulose, leaving the wood after attack with a white fibrous appearance. In the case of brown rots, extracellular enzymes are responsible for much of the decay, and much structural weakening may have occurred at a stage where there is little visual attack.

Originally, bacteria were thought to attack only chemically de-lignified wood, but Virtanen's work from 1928 onwards has shown that thermophilic

bacteria will ferment fine sawdust, and in 1951 American workers showed that even coarse sawdust can be fermented by bacteria with a nitrogenous supplement such as peptone or ammonium phosphate. Bacterial attack on solid wood probably occurs only in really damp conditions. Attacked wood shows dull discolorations and is weakened; minute pits and perforations are formed in the walls.

In addition to stain spoilage, microfungi are also responsible for soft rot. This occurs in marine piles and in water-cooling towers, but it is of importance only occasionally in timbers above the ground. Generally there is a soft dark-coloured surface zone of decayed wood which scrapes away easily and shrinks and cracks and takes on a typical brown 'charred' appearance when the wood dries out. In the rotted layer fungal hyphæ can be seen within the secondary cell wall. Species of *Chaetomium*, *Stysanus* and *Trichurus* can cause this type of decay, which is normally of importance in those situations not suitable for wood-destroying Basidiomycetes. Wood submerged in water provides too low an oxygen concentration for Basidiomycetes, while the soft-rot fungi are more tolerant of these conditions. The latter are also more resistant to preservative and sometimes occur in wood proofed against decay.

Laboratory experiments with *Chaetomium globosum* illustrate the need of spoilage organisms for mineral and nitrogenous nutrients. In the absence of mineral salt mixture, experimental decay of wood blocks is slow, but when it is provided extensive rotting occurs at a rate equivalent to that of Basidiomycetes. Chemical evidence suggests that *C. globosum* decomposes cellulose but is unable to attack lignin.

Mr. L. D. Galloway (London) spoke about microbial spoiling of paint surfaces. The problem is not serious in the climates associated with the British Isles, being confined chiefly to damp walls, surfaces liable to condensation, such as laundries and greenhouses, and to splashing with nutrients as in breweries, cheese rooms, etc. Mould-resistant paints are in much greater demand in damp tropical climates.

The problem is essentially one of giving the paint a definite resistance to mildew. A film of several coats of paint (primer, undercoat and finisher) will not provide nutrient enough to support visible growths of mildew: glass or metal surfaces painted in such a way rarely become mouldy. Visible mildew in almost all cases arises from the wood, plaster or paper substratum supporting the paint film, or from surface contamination with nutrients. Since a paint coating plays a passive part, mildew spoilage usually implies that the unpainted support will become mouldy in damp conditions. In accord with theory, it is found that there must be atmospheric moisture greater than a minimum relative humidity and opportunity for infection. Latent infection in the substratum is probably of greater significance than external growth penetrating the paint film, and sterilization of the surface by heat or formalin before painting is advantageous. The nature of the paint film, its hardness, permeability to moisture, content of mould inhibitors (for example, zinc oxide), added preservatives or inhibitors liberated in the film on ageing are important factors in the formulation of the paint itself.

Among the commonest moulds on paint in Britain are the penicillia and the dark-coloured *Cladosporium herbarum* and *Pullularia pullulans*. These latter are less easily brushed off, since the pigment is in the mycelium, and they are also more resistant to ultra-violet light.

Mr. Galloway made a plea for work towards a standard rapid proving test for mould resistance of paints. He surveyed most of the existing tests, including panel, patch and laboratory tests. In the outdoor panel test exposure, paint films should be as far as possible on standard panels of wood, in an atmosphere of high relative humidity, with protection from insect and other contamination. Patch tests are made on a potentially mouldy surface such as a cellar wall, and the paint must be compared with other paints and not with the untreated wall. In any case, the result has only local significance. Of various accelerated laboratory tests with filter paper, agar, wood pulp mats, plaster and wood blocks, the last is probably most suitable. Small blocks of pine sapwood, with their surfaces pre-coated with a thin layer of malt gelatin, are painted as required and hung in an atmosphere of 100 per cent relative humidity for a month. The natural fungi (mainly penicillia) always become dominant and obviate the need for inoculation. Although reproducibility in a test is a highly desirable property of a laboratory test, good correlation with behaviour in practice is far more important, and in this way the wood block test is possibly most successful.

The very large field of textile materials was dealt with by Dr. R. Burgess (Manchester), who pointed out that natural fibres are very readily decomposed under suitable conditions of nutrients, moisture and warmth, although artificial fibres like glass and nylon are very resistant to attack. Damage to natural fibres can occur at all stages of processing and storage, and results in the actual breakdown of the structure (tendering) or in discoloration and smell (mildew), which in turn often leads to unevenness in dyeing. In cotton, the cell wall of the fibre is attacked, but in jute, hemp and animal fibres the cementing material is first dissolved, leading to fraying and an increased surface area for attack. Except in soil burial, final breakdown of cellular elements of wool is rare.

The various factors outlined in Dr. Richards's introduction are well exemplified in microbial attack on textiles. The raw fibres contain a complete range of nutrients and are most readily attacked. Since processing removes a great deal of nutrient, there is increased resistance to spoilage, but the addition of farinaceous and gelatinous dressings considerably reduces resistance, and goods contaminated with nutrients are very susceptible. Trouble is most prevalent in warm weather, and tropical climates with a humidity greater than 75–90 per cent result in very rapid growth of moulds. The structure of the fibre is significant: light soft fabrics deteriorate more rapidly than heavy hard-twisted yarns. Increased susceptibility is caused by mechanical damage, abrasion, weathering and sunlight, as well as by chemical deterioration of the fibres.

Of the natural fibres, cotton is most easily attacked and mildews most readily as unbleached cloth. A long list of moulds is responsible, and as many as half of these can cause tendering by cellulose attack. Fungal breakdown is commonest in damp aerobic conditions, while bacteria will rot anaerobic wet fibres like fishing nets. In flax the fibres, being unlignified, are prone to attack but lack nutrients through earlier microbial processing, so that in fact linen suffers less than cotton. Jute and hemp have inherently greater immunity through their lignin con-

tent and suffer attack only at humidities greater than 85 per cent. Most rayons (regenerated cellulose) lack nutrients and show some resistance, while cellulose acetate 'silk' is largely unaffected by micro-organisms.

Animal fibres are less liable to attack than cotton; but even so, large losses may occur in warm weather, and again prevailing humidity is the key factor. Wool withstands greater humidity than cotton, and scoured wool only mildews at about 94 per cent relative humidity (about 19 per cent moisture content by weight). Woollen fabrics kept wet, like bathing costumes and paper-makers' felts, suffer bacterial attack, largely by spore-forming rods. Soaps and alkali aid microbial action by providing available fatty-acid and hydrolysed protein, and of paramount importance is the soluble nitrogenous matter. Horse, calf, pig and human hairs offer great resistance, but camel hair, which is fine and soft, is very susceptible. Silk is more resistant than wool, degummed thoroughly-washed silk being similar to regenerated cellulose rayons.

Methods of control of spoilage depend upon whether the need is short-term mildew-proofing during processing and storage or the more persistent powerful action required in rot-proofing. Control of mildewing can be made easier by the adoption in the industry of lower moisture-regain standards, together with reducing mildew capacity by thorough scouring and avoidance of farinaceous sizing materials; and the inclusion of a silica gel or similar desiccant in shipping consignments can be of value. Mildew-proofing by added fungistatic substances is effective, and salicyl anilide alone or paired with silico-fluoride, *p*-nitro-phenol, mercaptobenzthiazole, or acetanilide has excellent proofing qualities. Rot-proofing is a much greater problem in that a substance specific against a wide range of micro-organisms must be used, and this material must be insoluble and stable enough to withstand sun, weather, wetting and drying over long periods. Dr. Burgess dealt critically with the use of many materials for proofing both cotton and wool.

The testing of mildew-proofing of fibres and fabrics is best accomplished by field-trials, but accelerated laboratory tests are useful in which the material after inoculation with test cultures is held at warm-room temperature at humidities of 87–100 per cent and assessed by visual inspection. Rot-proofing tests require pure culture inoculation or soil burial followed by tests of mechanical strength.

The factor mainly relied on in the prevention of spoilage of paper and paperboard is the use of fungistatic materials. Mr. E. Howard (Kenley), who dealt with this subject, pointed out that paper and, to a much greater extent, paperboard are impure cellulosic materials often containing, in addition, rosin, wax, starch, gelatin and many other organic and inorganic substances in varying amounts. Storage conditions of these wrapping and packing materials frequently involve warmth and high humidities, often from their contents, so that frequent loss of strength by rotting and disfigurement by mildewing are not surprising. The only reliable way of preventing losses is to use an effective fungistatic substance, incorporating it either in the paper pulp or impregnating the paper web with it before drying, of which the first is probably more suitable. Mr. Howard listed the qualities desirable in a fungistatic, among the most important of which are a 'biologically active' persistence and ease of incorporation with the pulp stock, having no harmful effect upon the manufacturing process nor any hazards to personnel during manufacture or in later use. The material must not prevent the disposal of paper-mill effluent, should not impart any undesirable property to the product, and must provide protection at an economic price.

Copper and zinc naphthenates are effective, but give a dark, greasy product with an unpleasant smell and an ability to stain contiguous material. Sodium pentachlorophenate has been widely used, but is steam-volatile and partly lost in the drying section of the making process, besides giving a phenolic odour to the product. 2.2-Methylene *bis* (4-chlorophenol) is an excellent relatively non-toxic preservative, not affecting colour or feel. The very effective organic-mercurial compounds are very poisonous and raise the matter of toxic hazards in the industry. However, one of them, phenyl mercuric dinaphthyl methane disulphonate, was described as being substantive to tissue protein, and its passage into general circulation is prevented; indeed, it is apparently in use as a wound dressing. These three substances, sodium pentachlorophenate, 2.2-methylene *bis* (4-chlorophenol) and phenyl mercuric dinaphthyl methane disulphonate, are being exhaustively tested by the British Paper and Board Industry Research Association in accelerated laboratory tests made with impregnated strips of board in contact with Czapek agar in Petri dishes. Three test organisms, *Chaetomium globosum*, *Aspergillus niger* and a *Penicillium* species, are sprayed on singly or mixed as spore suspensions. After two weeks incubation the amount of mould growth is recorded and, when required, the mechanical strength of the paper strip is compared with uninoculated controls. The results indicate that mould-resistant samples were obtained when the following percentages on the dry weight of the fibre were used: phenyl mercuric dinaphthyl methane disulphonate, 0·25 per cent; 2.2-methylene *bis* (4-chlorophenol), 1·5 per cent; and sodium pentachlorophenate, 1·5 per cent.

The papers described briefly above will be published *in extenso* in the *Proceedings of the Society for Applied Bacteriology*.

T. Richards

OBITUARIES

Prof. Edwin J. Cohn

Edwin J. Cohn, Higgins university professor at Harvard University, died in Boston on October 1. He was an outstanding investigator of the physical chemistry of proteins, and the initiator and organizer of the large-scale systematic fractionation of blood plasma proteins, which has made important contributions to medicine and public health. He was born in New York City on December 17, 1892, the son of Abraham and Maimie Einstein Cohn. His decision to undertake a scientific career was made while he was a student in Amherst College. On the advice of Jacques Loeb, he transferred to the University of Chicago, where he received the B.S. degree in 1914, and the Ph.D. in 1917. His doctoral thesis dealt with the physiology of spermatozoa and the physical chemistry of sea water, the latter study being undertaken with Lawrence J. Henderson, of Harvard, who, together with Loeb, was an important guiding influence in Cohn's development. At this point Cohn decided to devote himself to the study of proteins, as substances of prime importance to the

living organism, and that decision guided him throughout the rest of his career. Protein chemists were relatively rare in those days. Cohn studied with two of the greatest—Thomas B. Osborne in New Haven in 1917, and S. P. L. Sørensen in Copenhagen in 1920. During the Second World War he worked with Henderson on the physical chemistry of bread-making—a problem then of urgent practical importance. He returned from Europe to Harvard in 1920, when Henderson offered him a position in the newly created Department of Physical Chemistry in the Medical School. This Department, of which he shortly became the head, was the centre of his activity for the rest of his life.

Prof. Cohn's early researches were concerned with the factors affecting the solubility and the acid-base equilibria of proteins; he was one of the first to recognize the importance for protein chemistry of the Debye–Hückel theory of interionic forces, and to apply it in his solubility studies. The discovery of the liver treatment of pernicious anæmia by Minot and Murphy led him to undertake the purification of the active principle. Isolation of the active component—identified twenty years later as vitamin B_{12}—was not achieved; the human patient was at that time the only available experimental animal for testing the liver fractions, and all available patients were rapidly cured. However, the practical advance achieved was great; the extracts prepared by Cohn's methods promptly replaced whole liver in treating the disease.

These studies never deflected him from his concern with protein chemistry. However, about 1928 he turned to the study of the amino-acids, peptides and related substances as simple models of known structure which might be employed to elucidate obscure aspects of the physical chemistry of the proteins. The recognition by E. Q. Adams and N. Bjerrum that amino-acids, when electrically neutral, were dipolar ions (*Zwitterionen*) served as a clue of fundamental importance in these studies. Cohn became the centre of an active group of investigators, who explored the far-reaching implications of dipolar ion structure of proteins, amino-acids, and peptides. Among other accomplishments, much was achieved in relating solubility to structure in compounds of this class, in terms of electric charge distributions within the molecule, of the presence of polar and non-polar groups, and of the effects of the dielectric constant and the ionic strength of the medium.

The work of the laboratory began again to centre on the proteins about 1938; and this tendency was accelerated by the outbreak of the Second World War. Cohn was early aware of the gravity of the problem of blood transfusion, and he recognized that concentrated serum albumin would have many advantages over whole plasma as a transfusion medium. Moreover, the other fractions of blood plasma proteins could then also be separated from the same blood, and made available for clinical use, each for a particular function. With support from the Office of Scientific Research and Development, and with the great war-time blood-donor programme of the American Red Cross, this vision was carried into practice with extraordinary success. More than half a million transfusion units of serum albumin, derived from about two million blood donations, were prepared in the United States during 1942–45, in addition to the vast number of donations used as whole blood or for dried plasma. Gamma-globulins, fibrin foam and film, and isoagglutinins for blood typing were other practical products of the fractionation programme. The large-scale methods of separation developed, involving precipitation with ethanol at low temperatures, with careful control of *p*H and ionic strength, were profoundly influenced by the earlier studies on amino-acids and peptides; the rapid progress made in the war-work would indeed have been impossible without the theoretical background developed over the earlier years.

The scale of operations in the war-time programme was indeed large, requiring close collaboration between chemists, clinicians, immunologists and others, and rapid industrial application of the processes worked out in the Harvard pilot plant. Cohn was the driving force behind the programme; his extraordinary gift for directing and co-ordinating a great organization, which he himself had largely created, was for the first time called fully into play. The concentrated attention which he devoted to every detail of every process was astonishing; plans for improvements and modifications poured forth from him in a never-ending stream, and the enthusiasm with which he pressed his colleagues to put every new idea immediately into practice was at times somewhat overpowering. Yet, with all his passion for detail, he never lost his vision of the situation as a whole.

After the War, the laboratory drew visiting investigators from all over the world—more than thirty came from foreign countries between 1946 and 1953, as well as many from within the United States. The emphasis in research shifted toward fundamental studies on proteins, especially blood proteins, but a close relation to problems of medicine and public health remained. Indeed, Cohn drew no distinction between pure and applied science; he devoted himself with equal zeal to abstract questions of protein structure and to the problems of making albumin and gamma-globulin available on a large scale, and with proper safeguards, to the public. During the last years of his life he developed a machine for making blood fractionation largely an automatic procedure; this is now being manufactured on a small scale for trial use in blood donations, and may lead to further far-reaching developments.

Cohn was twice married: to Marianne Brettauer in 1917, and, after her death, to Rebekah Higginson in 1948. His home was always a centre of hospitality for numerous friends and colleagues. Besides the passionate intensity with which he devoted himself to his research interests, he retained a keen interest in art and literature, and was an active student of the history of science. The numerous workers who came to undertake research with him underwent a discipline both exacting and imaginative, and many will retain vivid memories of an intensely active laboratory headed by an extraordinary man.

JOHN T. EDSALL

Prof. Stefan Pieńkowski

THE death on November 20 of Prof. S. Pieńkowski, coming so soon after that of Prof. C. Białobrzeski, has dealt a grievous blow to Polish science, which has thus lost its acknowledged leaders in both experimental and theoretical physics.

Stefan Pieńkowski was born in 1883 in a small Polish town, then under Russian occupation. After his early education at home he went to study at the Universities of Heidelberg and Liège, where he later was a member of the teaching staff. Immediately

after the liberation of Poland in 1919 he returned to Warsaw, where he was appointed to the chair of experimental physics at the University, a position he held until his death. When he took office the Physics Department was practically non-existent; but within a few years he built it up into one of the most up-to-date and best-equipped institutions for research and teaching on the Continent of Europe. He also created a very large and active school, from which have come many of the present leading physicists in Poland.

During the Second World War, the Physics Institute at Warsaw was almost completely annihilated; most of the equipment was taken away to Germany and the buildings seriously damaged. Undaunted, Prof. Pieńkowski carried on with teaching and scientific activities in the underground University. Immediately the War ended, he began to rebuild the Institute, and despite difficult conditions he managed to bring it back to its former splendour.

His research work was mainly concerned with spectroscopy and photoluminescence; he was particularly interested in molecular structure, in which work he also employed X-ray spectroscopy. Later, he developed an interest in nuclear physics and installed in his Institute the first proton accelerator in Poland. Plans for the building of other accelerators had to be abandoned because of the War; but he encouraged work on nuclear physics and cosmic rays and has sent some of his most promising pupils to study in laboratories in Great Britain.

Apart from research and teaching, Prof. Pieńkowski took a very active part in the organization of science in Poland. For several years he was rector (vice-chancellor) of the University of Warsaw, and he resumed this office immediately after the War with the formidable task of rebuilding the University from the ruins. He also took a leading part in the work of the Polish Academy of Science and in recent years was put in charge of its Physics Section, which included the development of atomic energy.

All these outside activities did not diminish his devotion to his own Institute, in which he took the greatest interest and where he was revered by every worker. His was the rare personality which combined a genius for organization and exceptional administrative skill with a remarkable talent for teaching and a youthful zeal and enthusiasm for scientific investigation. J. Rotblat

Mr. T. H. Withers

Thomas Henry Withers, an authority on fossil crustaceans, died on October 2 at Bournemouth, where he had been living since his retirement in 1944 from the staff of the British Museum (Natural History). Born in London in 1883, he became in 1898 a boy attendant in the Geological Department of the Museum, where his natural ability and enthusiasm soon received encouragement from F. A. Bather, who eventually, in 1925, established him on the scientific staff.

In 1910 Withers published the first of a long series of papers on fossil cirripedes. Among these contributions were extensive accounts of the cirripedes of the Rügen Chalk (1923) and of New Zealand (1924); but at an early stage in his career he had planned a monographic account of the whole group, which had not been revised since Darwin's day. Starting with the Palæozoic, he was able to show that certain problematical organisms (including *Turrilepas*), then usually referred to the cirripedes, were in fact not arthropods at all, but belonged to an isolated group allied to the echinoderms which he named, in a volume published by the Trustees of the British Museum (1926), the Machaeridia. His "Catalogue of Fossil Cirripedia" appeared in three volumes: the first, on Triassic and Jurassic forms, in 1928; the second, on the Cretaceous, in 1935; and the third, on the Tertiary, in 1953, just over a century after the appearance of Charles Darwin's monograph. In 1851 Darwin knew only four Tertiary species; Withers dealt with ninety-three, no less than forty-three of which he had himself instituted. He was interested, however, not so much in the mere description of material as in the phylogeny of the various forms and in the evolutionary significance of structural changes. The same approach inspired his studies of Mesozoic crabs, in which he discussed the origin and evolution of the Brachyura.

Although hampered by ill-health after his retirement, Withers continued his scientific work to the end, and at the time of his death had almost completed an account of the cirripedes for a forthcoming treatise on invertebrate palæontology.

W. N. Edwards

Dr. H. E. Ives

Dr. Herbert Eugene Ives was the distinguished son of a distinguished father. Born in 1882 in Philadelphia, he had his early education in physics at the University of Pennsylvania, followed by two years at Johns Hopkins University as a Fellow. He worked in turn at the U.S. Bureau of Standards, the National Electric Lamp Association, the United Gas Improvement Co., the Western Electric Co., and finally at the Bell Telephone Laboratories. He had one break, as an officer in the United States Army in 1918, when he was in charge of research on aerial photography, and another during 1941–45 when he was head of a section of the National Defense Research Committee.

He was a member of many scientific societies, and served as president of the Optical Society of America and of the American Numismatic Society. He was a corresponding member of the British Illuminating Engineering Society, and a Fellow of the Physical Society, before which he delivered the Thomas Young Oration in 1933. In the same year he gave the Traill-Taylor Memorial Lecture before the Royal Photographic Society. Among other honours he received the Frederic Ives Medal (founded in memory of his father) from the Optical Society of America.

Ives's work was mainly in the field of applied optics, but in this field he roamed widely. His earliest work concerned colour photography, and this led him to examine the efficiency of illuminants, a subject to which he frequently returned. The width of his approach is shown by the inclusion of the firefly among illuminants. In studying illuminants, he improved the practice of photometry, showing among other matters the origin of some discrepancies found in flicker photometry. In considering illumination, it was natural to him to study spectrophotometry and various receivers of radiation such as photoelectric cells, thermopiles, and—as a special case—the eye.

The effect of his connexions with the telephone laboratory was to cause him to work on electric contacts, and to intensify his interest in photo-electric cells. Under his guidance, the transmission of pictures was developed and demonstrated in 1924. In 1927 his group gave a demonstration of television. Later, he worked on the projection in relief of moving pictures. In 1930 he demonstrated two-way television for the first time, and worked on the problem of television in colour. His interest in colour led him to devise a three-colour palette for the artist, and this was the subject of his Thomas Young Oration.

In later years Ives became interested in relativity problems, especially the effects of movement on rods and clocks, and most of his writings since the end of the Second World War were concerned with such problems. Experiments in conjunction with Stilwell on the Doppler effect in hydrogen canal rays gave evidence supporting the Larmor–Lorentz theory, and in his writings Ives continually emphasized his belief in the reality of the ether.

From photometry to relativity, from fireflies to atomic clocks, Ives showed a breadth of interest infrequently matched in an age of narrow specialization.

A. C. MENZIES

NEWS and VIEWS

Institution of Electrical Engineers : Honorary Membership and the Faraday Medal

Two honours have recently been conferred by the Institution of Electrical Engineers. Mr. Ernest Leete has been elected to honorary membership of the Institution for his outstanding services to the Institution, in particular for his services as honorary treasurer and as an ordinary member of council over a period of almost a quarter of a century, and also for his work on behalf of the Benevolent Fund of the Institution over a similar period of years. The thirty-second award of the Faraday Medal has been made to Mr. Isaac Shoenberg for his distinguished work in electrical engineering, in particular the outstanding contributions which he has made to the development of high-definition television in Great Britain.

Mr. Ernest Leete

MR. LEETE was born at Wallington, Surrey, in 1886 and was educated at Uppingham School. In 1904 he joined the London Electric Wire Co. and Smiths, Ltd., and was afterwards appointed secretary, secretary and director, managing director and consultant. He served as chairman of the Cable Makers' Association in 1928. He was first elected to membership of the Institution in 1917, and on three separate occasions he served the full period of three years as honorary treasurer : during 1929–32, 1940–43 and 1946–49. With two other members of council he evolved in 1939 a series of recommendations regarding the financial policy of the Institution which have formed the basis of the present financial security which the Institution now enjoys. Mr. Leete's interest in the activities of the Benevolent Fund have extended over some twenty years or more, during ten of which, except for short periods, he served as deputy chairman of the court of governors. He was one of the prime movers in the inauguration of the Homes Fund for the development of "The Chesters" residential estate. He was appointed chairman of the Homes Committee on its inception in 1945.

Mr. Isaac Shoenberg

MR. SHOENBERG was born in Russia in 1880, where he received his early technical education, and afterwards took postgraduate courses at the City and Guilds College and the Royal College of Science, London. After serving as chief engineer of the Russian Wireless Telegraph and Telephone Co., St. Petersburg, during 1905–14, he went to Britain to take up an appointment as consulting engineer to the Marconi Wireless Telegraph Co., later becoming head of the Patent Department and finally joint general manager of the Company. In 1928 he was appointed joint general manager of the Columbia Gramophone Co., and in 1931 he went to Electric and Musical Industries, Ltd., where he led a team of scientists which developed the television system with its ancillary equipment that was adopted by the B.B.C. in 1936. This work involved the development not only of circuits but also of new types of electronic devices such as the cathode-ray receiving tubes with modulated cathode stream and magnetic focusing and scanning. His development of the electronic picture tube known as the 'Emitron' contributed perhaps more than any other single item to the success of the new system. Early in 1937, Mr. Shoenberg was able to offer to the Post Office and to the B.B.C., transmission equipment, including special cables and repeaters, which enabled scenes of the coronation procession of King George VI to be televised. With the great success of the television programme of the Queen's Coronation last year still very much in public memory, the Institution decided that it would be most appropriate to award the Faraday Medal to one who has been a leading pioneer in developing television broadcasting.

Queen's University, Kingston, Canada : Prof. J. K. N. Jones

DR. J. K. N. JONES, reader in organic chemistry in the University of Bristol, has been appointed Chown research professor in chemistry in Queen's University, Kingston, Canada, and took up his new duties on October 1. He is a graduate of the University of Birmingham, where he carried out post-graduate research on the synthesis of vitamin C and its analogues under the direction of Prof. E. L. Hirst and the late Sir Norman Haworth. In 1937 he accompanied Prof. Hirst to Bristol, and together they pursued carbohydrate investigations which in many cases involved new techniques for handling this complex group of substances. Prof. Jones has elaborated techniques of methylation, periodate oxidation, and, in particular, paper chromatography for structural investigations of plant gums and mucilages, algal polysaccharides, pectic substances, hemicelluloses, starches and glycogens. During the Second World War Prof. Jones investigated nitration processes and held a commission in the Signals Section of the University of Bristol Senior Training Corps. In 1945 he joined the staff of the University of Manchester, and in 1948 returned to Bristol as reader in organic chemistry. Within recent years he has

organized the bio-organic section of the new honours course in biological chemistry at Bristol, which coincides with his increasing interest in the bio-synthesis of sugars.

Mineralogy in the British Museum (Natural History): Dr. G. F. Claringbull

Dr. Gordon Frank Claringbull has been appointed to the keepership of the Department of Mineralogy in the British Museum (Natural History) in succession to Dr. F. A. Bannister, who has retired on account of ill-health. Dr. Claringbull was educated at Finchley County School and Queen Mary College, University of London. He joined the staff of the Department of Mineralogy in the Museum in 1935 and was at first engaged in petrological work; later he went on to work on X-ray methods of mineralogy. Early in the Second World War he joined a group working under Dr. E. G. Cox in the University of Birmingham on research for the Ministry of Supply. Later he took charge of the group until in 1943 he again joined Prof. E. G. Cox on Combined Operations Operational Research. He returned to the Museum in 1945. Since then he has been engaged on the X-ray study of minerals and on arranging special exhibits of crystal structure and gemstones. His discovery of the new gem mineral sinhalite attracted considerable interest. He is a vice-president of the Gemmological Association of Great Britain, and has been general secretary of the Mineralogical Society since 1938.

The retirement of Dr. Bannister is a great loss to science. It is the earnest hope of his friends that he may soon recover his health, and that he will then be able to resume the researches in mineralogy and X-ray crystallography by which he had already established an outstanding reputation.

Advisory Committee on Government Support of Universities and Colleges in the United States

The National Science Foundation, Washington, D.C., has established an advisory committee to consider the question of government support to colleges and universities in the United States and its effect on their research and teaching functions. The committee is composed of a chairman, Chester I. Barnard, of the National Science Board, and twelve members as follows: Arthur S. Adams, president, American Council on Education; Vannevar Bush, president, Carnegie Institution of Washington; James S. Coles, president, Bowdoin College; Harold W. Dodds, president, Princeton University; Conrad A. Elvehjem, dean of the Graduate School, University of Wisconsin; T. Keith Glennan, president, Case Institute of Technology; Virgil M. Hancher, president, State University of Iowa; William V. Houston, president, Rice Institute; Clark Kerr, chancellor, University of California, Berkeley; C. N. H. Long, professor of physiology, Yale University; Don Price, associate director, the Ford Foundation; and Julius A. Stratton, provost, Massachusetts Institute of Technology.

A feature of the post-war era in the United States is that very large sums of money have been paid by government agencies for technological development in universities and colleges, whereas much smaller amounts have been provided for pure research and education in the sciences, although in many respects these institutions are uniquely fitted for carrying on such activities. A closely related question to which the committee may also give attention is how the Federal Government itself, in co-operation with the colleges and universities, may best develop and encourage research and education in the sciences. Statistics compiled by the Foundation indicate that during the year ending June 30, 1952, educational institutions received almost 300 million dollars from Federal agencies for development and research. Approximately 136 million dollars (46 per cent) was spent by instructional departments, and of the rest, about 3 million dollars was spent by affiliated research organizations, 12·5 million dollars by agricultural experimental stations, and 143·5 million dollars by research centres which were administered by educational institutions for specific Federal agencies but segregated with regard to their organization from the normal activities of the institutions. A total of 225 educational institutions received some Federal support for development and research during 1951–52, and these included 86 universities, 95 liberal arts colleges, 41 professional–technical schools, and three other educational institutions.

Help for Foreign Scientists visiting Britain

The Horse Shoe Club, the Ciba Foundation and the Society for Visiting Scientists wish to make known the various forms of help which they can offer to scientific men visiting Britain. The Horse Shoe Club was formed in 1932 and now has British, United States and Canadian sections, there being more than four hundred members. The objects of the Club are the fostering of friendship and the exchange of medical research and clinical workers between the United States, Canada and Great Britain, and the British section offers its help and hospitality to all visiting United States and Canadian medical workers, both on a professional and personal basis. Further information can be obtained from the honorary secretary, Dr. C. S. Nicol, St. Bartholomew's Hospital, London, E.C.1. The Ciba Foundation is an international centre, supported by contributions from the chemical and pharmaceutical firm which has its headquarters in Basle, but is entirely independent of the firm in its operation, being registered as a scientific and educational charity under British law. It operates in the field of medical and chemical research, its function being to provide information and to arrange from time to time conferences, lectures, etc.; in addition, it will provide free accommodation to scientific workers visiting London for short periods in the course of their work. Further details can be obtained from Dr. G. Wolstenholme, Director, Ciba Foundation, 41 Portland Place, London, W.1. The Society for Visiting Scientists, Ltd., seeks to be a centre for all scientists visiting the United Kingdom and to put them in touch with British scientists and one another. The House of the Society provides a meeting place, a refectory, a bar and some residential accommodation. Any scientist arriving in Britain can, if he wishes, proceed at once to the House and be given such advice and information as is available. In addition, a body of information concerning science and scientists, not easily available elsewhere, is freely at the disposal of individual scientists and scientific institutions. All inquiries should be directed to Miss E. Simpson, Assistant Secretary of the Society, 5 Old Burlington Street, London, W.1.

Investigation of Oil Pollution by Drift Envelopes

Arrangements have now been completed by the National Institute of Oceanography and the Royal

Air Force Coastal Command for the dropping of plastic drift envelopes into the Atlantic Ocean to the west of the British Isles, with the object of discovering seasonal changes in the speed and direction of the ocean currents which are believed to carry oil patches to the beaches of Britain (see *Nature*, October 24, 1953, p. 750). A reward of half-a-crown will be paid to the sender of each postcard (contained within the envelope), which is returned to the National Institute of Oceanography, Wormley, near Godalming, Surrey, with the simple questionnaire which is printed upon it filled in. Weather permitting, aircraft of Coastal Command, each carrying a scientist from the Institute, will make the first flights on January 20, and further flights will be made during the spring, summer and autumn. The dropping track on this winter flight will extend in a rough semi-circle from the centre of the Bay of Biscay to half-way between the north of Scotland and Iceland, the total length of the track being some 2,100 miles. The speed of the aircraft will average about 150 m.p.h., and the envelopes will be dropped in bundles of ten, secured with gummed paper strip which will detach itself after a short time in the sea, the rate of dropping being such as to give an average of one envelope a mile. The envelopes in each bundle will be dispersed over a wide area before they reach tidal waters. It is expected that the first of the envelopes will strand during the middle of March, but their date of arrival will depend very largely on the wind during the time they are afloat. Arrangements have also been made with the Meteorological Office and the Netherlands Weathership Commission for Ocean Weather Ships at Stations "India" (61° N., 15° 20′ W.) and "Juliett" (52° 30′ N., 20° W.) to drop one plastic envelope at noon each day throughout this year.

Radioactive Corticosterone

A NUMBER of Federal, university and private organizations in the United States have collaborated, with funds supplied by the National Institute of Arthritis and Metabolic Diseases of the United States Public Health Service, to produce a limited supply of radioactive corticosterone (compound B), which is now available to qualified investigators, free of charge. Last July, radioactive cortisone acetate and hydrocortisone were made available (see *Nature*, 172, 187; 1953), and now, in conjunction with the latest announcement, supplies can be obtained of the following intermediates in the synthesis of cortisone acetate: pregnane-3,11,20-trione; 3α,17α-dihydroxypregnane,11,20-dione; and 17α,hydroxy-21-acetoxypregnane,3,11,20-trione. In addition, microcurie samples are available of 3α,17α-dihydroxy-21-acetoxypregnane,11,20-dione and 3α,acetoxypregnane, 11,20-dione. All these compounds are labelled with carbon-14 at position 4, and have a specific activity of 0·49 mc./m.mole, except the corticosterone, which has a specific activity of 1·47 mc./m.mole. Cortisone acetate, identically labelled, having a specific activity of approximately a third that of the activity previously announced for cortisone acetate, can also be obtained. Requests for any of the compounds should be made in the form of a letter, describing precisely the proposed research, and sent to the Endocrinology Study Section, Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland. The transfer and use of these materials are subject to current regulations of the United States Atomic Energy Commission.

The Society for Analytical Chemistry

AT an extraordinary general meeting of the Society of Public Analysts and Other Analytical Chemists, held in London on December 17, 1953, the name of the Society was changed to the Society for Analytical Chemistry. The existence of this body dates back to its founding at a meeting held on August 7, 1874, when it was named the Society of Public Analysts, membership being restricted to practising public analysts and their assistants. But in course of time analytical chemists other than public analysts were also admitted as members, and on August 7, 1907, when the Society was incorporated, its extended membership was recognized by the adoption of the title of the Society of Public Analysts and Other Analytical Chemists. To-day the Society has far outgrown its original purpose of looking after the professional needs of the public analysts, which are now well served by the newly formed Association of Public Analysts; the new Association is receiving the full support of the Society, financial and otherwise. The developments in analytical chemistry have been vast and striking during this century, but, although the Society's interest now extends over the whole range of natural and manufactured products, there will still be the same platform for the discussion of investigations into the composition of food and drugs. Indeed, it is intended that the character of *The Analyst* and of the ordinary meetings of the Society will be maintained unchanged, and that the Society will continue in its original aim of encouraging, assisting and extending the knowledge and study of all questions relating to the analysis, nature and composition of natural and manufactured materials generally. So as to encourage young chemists, the Society is starting a class of junior membership for those aged between eighteen and twenty-seven years; junior members will pay a considerably reduced subscription and no entrance fee, will receive *The Analyst*, and have the privilege of attending meetings.

Optica Acta: New European Journal of Optics

UNDER the ægis of the optical committees existing in various European countries, a new journal of optics will be appearing shortly, with the title *Optica Acta*. The aim is to provide in Europe a medium of publication for optical papers similar in scope and character to those which in the United States have their outlet in the *Journal of the Optical Society of America*. *Optica Acta* will be published in Paris by the Société de la Revue d'Optique under the direction of a board of control the thirteen members of which are leading optical research workers drawn from some seven countries, with Prof. J. M. Otero, of Madrid, as chairman. Further details can be obtained from the Assistant Secretary, Royal Society, Burlington House, London, W.1, who is also acting as collector for subscriptions in the United Kingdom.

Histochemistry and Cytochemistry in the University of Minnesota

IN the recently completed Lyon Laboratory Building of the University of Minnesota Medical School, an entire floor has been especially designed for studies of quantitative histochemistry and cytochemistry under the direction of Prof. David Glick, professor of physiological chemistry in the University. The funds for the construction of this accommodation have been provided by the National Heart Institute

of the National Institutes of Health, United States Public Health Service. The facilities include laboratories for quantitative microchemical analysis of histologically defined samples; optical, X-ray absorption and histology laboratories; and constant-temperature instrument, cold and animal rooms. Research and training programmes will be conducted at both the pre- and post-doctoral levels.

Energy of Ultrasonic Waves

Dr. S. Parthasarathy and his colleagues of the National Physical Laboratory, New Delhi, have recently published a series of papers on the equivalence of ultraso ic and thermal energies in a liquid (for example, *Ann. der Phys.*, **12**, 8; 1953). The method is to send progressive waves into a trough containing the liquid, to measure at various points the radiation pressure on a disk exposed to the radiation (from a 5-Mc./s. quartz oscillator) and to extrapolate the measurements back to the source to calculate the intensity there. The heat generated in the liquid after thirty minutes irradiation is also noted from the overall rise of temperature in the liquid by means of a special mercury thermometer which can be read to 0·025 deg. C. Correction is made for dielectric heating which is of the same order as that due to ultrasonics, both averaging half a degree rise in half an hour. From pairs of results, values of the mechanical equivalent of heat are deduced. The average value works out at 4·19 joules/cal. to $\pm 3\frac{1}{2}$ per cent.

The Silicon Alloy Diode

A recent product of the extensive research programme on transistors carried out at the Bell Telephone Laboratories is the silicon alloy diode, details of which have now been published (*Bell Lab. Rec.*, **31**, 361; 1953). As the electronic equivalent of a tiny one-way switch, it is capable of operating thousands of times faster than its mechanical counterpart, and its use may result in significant advances in telephone switching devices and in several types of electronic computers. A specially grown silicon crystal containing controlled traces of an impurity is used, and in the process of preparation the normal high electrical resistance of the mineral is reduced, enabling rectification to occur. The back leakage is claimed to be less than in any previous diode. Like the germanium transistor, the silicon alloy diode has no filament, vacuum or warming-up period, but, in addition, it can be operated quite successfully under high temperatures.

Determination of the Variations of Eclipsing Variable Stars

The results of the investigations made by R. Szafraniec on the variations of period of the eclipsing variables *RZ* Cas, *TY* Boo and *TU* Boo are given in *Acta Astronomica* (published in Cracow; Ser. *b*, **2**, 86; 1953). The observations were made at the astronomical station of the National Astronomical Institute, Lubomir, during 1934–35, and at the Astronomical Observatory of the Jagellonean University, Cracow, during 1947–51. A total of fifteen thousand observations were made, and 1,371 of these were used in the paper. The author made use of the results of other observers in the investigations of the variations of the periods, or worked out their observations *de novo*. In determining the times of minima, different methods, partly new, were used in the reductions of observations, and the second part of the paper deals with the comparison of these different methods. It is interesting to know that the tracing-paper method was not only the most convenient but was also superior as regards the results to all other methods. A detailed description of the application of the least-squares method is given. Light curves of the three stars and a number of tables provide a very convenient summary of the author's work, the results of which are compared with those of others, and the opinion is expressed that in order to establish the causes of the variations of period it is necessary to carry out joint investigations of a greater number of stars on the basis of sufficiently ample material.

Growth and Morphogenesis in Forest Species

It has been ascertained by G. H. Duff and N. J. Nolan (*Canad. J. Bot.*, **31**, 4, 471; 1953) that the anomalous character of the annual rings of young trees, as in *Pinus resinosa*, is attributable to a remarkably thorough organization of ring width, and therefore of cambial activity, under the impact of intrinsic factors. The latter are thought to include nutritional gradients in the axis. The authors describe the system of observation adopted, and indicate that the complex relation between the responses of the cambium and those of the apical growing-point to random extrinsic factors can be referred to the discontinuity of terminal growth introduced by the winter pause between bud formation and axial extension. These two stages of terminal growth are influenced by the external factors of two different years. The effect on the cambium is somewhat simpler, but is directly related to that on the apical growing-point. It is held that the results obtained should help to prepare the way for the use of young trees in studies of the factorial control of growth.

Scholarships for One-Year Courses in Personnel Management

Under the arrangements set out in the White Papers (Cmd. 8776 and 8918) for expenditure of Counterpart Funds on advisory services, research and education (see *Nature*, **172**, 528; 1953), the Government proposes to make funds available to the Institute of Personnel Management for the award of a small number of scholarships for one-year courses in personnel management at certain universities and colleges. The courses are for men and women, not less than twenty-four years old, who already have had experience in industry or commerce in Great Britain or Northern Ireland, and are primarily intended to assist them to attend courses of training in personnel management which would otherwise not be available to them. The scholarships will be worth £300, with a dependants' allowance of £100 for a married candidate with one or more children, and in special circumstances an additional grant not exceeding £50, and will be available for the academic year, beginning in October, at one of the following: London School of Economics; College of Technology, Manchester; Glasgow and West of Scotland Commercial College and Royal Technical College (jointly); University College, Cardiff; University of Liverpool (postgraduate course in industrial sociology). Further information regarding the content of the courses is available in the booklet "Training for Personnel Management", which is obtainable from the Institute (price 1*s.* 6*d.*) or direct from the universities concerned. Application forms can be obtained from the Secretary, Institute of Personnel Management,

Management House, 8 Hill Street, London, W.1, or from any of the above universities or colleges; the forms should be returned to the Secretary of the Institute not later than January 31.

International Exchange of Students for Technical Experience

THE sixth annual report of the International Association for the Exchange of Students for Technical Experience (pp. 66; from the Association, Imperial College of Science and Technology, London, S.W.7; November 1953) records a smaller increase (290) in the international exchange than during 1952. With a total of 3,783 students exchanged, the excessive proportion of students withdrawing after nomination causes much unnecessary labour both to industries and to the administration of the Association. The report rightly emphasizes that national committees should make every effort to ensure that students nominated are made aware of their obligations to industry by completing the full period of training offered abroad. The administration of the exchange in some of the seventeen member countries still leaves much to be desired, and the benefit derived by a member country depends largely on the energy and efficiency with which it carries through the work of the Association. Nevertheless, during 1952 the Association was able to exchange 3,493 students at an administrative cost per student, including the printing of the fifth annual report, of 3*s*. 1*d*. During 1953, 241 institutions in seventeen countries and twenty-seven faculties participated, as compared with seventy-three from ten countries and nineteen faculties during 1949, while the students were received by 1,733 institutions, compared with 550 in 1949 and 1,460 in 1952. Mechanical, electrical and civil engineering, mining, chemical engineering and chemistry, in that order, provided by far the largest number of students, and, with the exception that chemistry and chemical engineering changed places, the corresponding industries provided the great majority of places. More students were accepted than were sent in the following countries (excess given in brackets): Sweden (289), Great Britain (79), Switzerland (39), Canada (22), Norway (11), Germany (9) and Iceland (4). Of countries sending more students than they accept, Austria (160), Israel (58), Denmark (53), Yugoslavia (37), Finland (35), Belgium (29) and France (29) show the largest excesses. A list of institutions and firms participating in the scheme is given under each country. Great Britain sent abroad, in 1953, 544 students from twenty-seven universities and colleges, an increase of fifty-six over 1952, and received 623 students, an increase of twenty-one; about fifty places were not taken up.

International Union of Crystallography: Congress in Paris

THE Third General Assembly and International Congress of the International Union of Crystallography will be held in Paris during July 21–28, 1954. Delegates to the General Assembly, which will be concerned with the formal business of the Union, will be nominated by the national committees, but the International Congress is open to all crystallographers. The membership fee will be 3,000 francs for crystallographers and 2,000 francs for their friends. The subjects to be considered at the Congress will be as follows: instruments and measurements; new developments in structure determination; mineral structures, including synthetic minerals and ceramics; metal structures; inorganic structures; organic structures; proteins and related structures; random and deformed structures; liquids and liquid crystals; glasses; thermal transformations; diffuse scattering; crystal growth; neutron diffraction; and miscellaneous. No report of the Congress will be published, but full abstracts of the contributions will be distributed in advance. Those intending to read papers should send an abstract of about twenty-five words to the programme committee as soon as possible (in any case not later than February 15) and, if accepted, more detailed abstracts will be required before March 31. The three official languages of the Congress are English, French and German. As well as the papers on the above topics, a number of survey lectures will be arranged on subjects of general crystallographic interest. In addition, there will be two symposia after the Congress, during July 29–30, as follows: the location and function of hydrogen; and the mechanism of phase transitions in crystals. These symposia are intended for specialists, but all crystallographers will be welcome and introductory sessions will be arranged during July 21–28. In conjunction with the Congress an exhibition will be held of materials, apparatus, books, literature, etc., related to crystallography. Enrolments for the various meetings or space at the exhibition should be submitted on the appropriate form before February 15, and such correspondence together with all other matters concerning the Congress and the symposia should be addressed to the secretary of the local committee and of the programme committee, A. J. Rose, Laboratoire de Minéralogie, 1 rue Victor Cousin, Paris 5e. Correspondence relating to the General Assembly and the business of the Union should be referred to the general secretary, R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge.

World Power Conference Sectional Meeting

A SECTIONAL Meeting of the World Power Conference will be held in Rio de Janeiro during July 25–August 8, 1954. The conference proper will be held during July 25–31, and the papers will deal with the following seven subjects: planning of the electric power industry; the electric power industry in tropical and sub-tropical regions; natural and derived fuels; wind power; solar energy; uses of electric power; and international hydro-electric developments. During the following week the Brazilian National Committee will organize tours in which a number of hydro-electric stations, hydro and thermal plants, and petroleum installations, as well as places of cultural interest, will be visited. British persons who wish to participate should write at once to the Secretary, British National Committee, World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2.

Chemistry and Industrial Applications of Cellulose: Symposium at St. Andrews

IN 1947 and 1949 the Royal Institute of Chemistry held at the University of St. Andrews two symposia dealing respectively with recent developments in the organic chemical industry and in the fermentation industries. The success of these meetings has encouraged the Scottish Sections of the Institute to arrange a further symposium, to be held in the University during June 28–July 2, at which comprehensive reviews of recent advances in the

chemistry and industrial applications of cellulose will be presented. The symposium will be divided into three sessions, at the first of which, on the chemistry of cellulose and its derivatives, the following topics will be discussed: recent advances in the chemistry of cellulose; an organic chemical approach to cellulose technology; photo-degradation of cellulose; the 'activation' of cellulose; and cellulose acetate. At the second session, on paper and pulp, sources of cellulose for paper-making will be considered, followed by reviews of recent trends in Scandinavian pulp research and pulp manufacture, and fundamental studies on the physical and chemical properties of fibres for paper-making. Finally, the industrial applications of cellulose and its derivatives will be considered (cellulose ethers and their applications; textile finishing; packaging problems; and coloured film). Lectures and discussions will be held during the mornings, with informal meetings, works visits and social events in the afternoons. The registration fee for the symposium is two guineas. Registration forms and further information can be obtained from the Assistant Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: H. H. Croucher (director of agriculture, British Guiana), director of agriculture, Western Region, Nigeria; J. H. M. McNaughton (senior geologist, Northern Rhodesia), director of Geological Survey, Nyasaland; W. G. C. Forsyth (senior scientific officer, Colonial Microbiological Research Institute), principal scientific officer, Colonial Microbiological Research Institute; G. H. S. Wood (assistant conservator of forests, Uganda), senior scientific officer (forest botanist), North Borneo; J. W. Macaulay (senior veterinary research officer, Kenya), chief veterinary research officer, Kenya; R. N. Sanders (senior veterinary officer, Uganda), deputy director of veterinary services and animal industry, Uganda; Dr. L. E. Arnold (assistant bacteriologist, Jamaica), bacteriologist, Jamaica; M. S. Brooks (clerk, Grade 1A, East African Railways and Harbours), statistician, East Africa High Commission; C. W. Hewitt (agricultural chemist, Jamaica), senior agricultural chemist, Jamaica; W. P. Langridge (assistant field zoologist, Veterinary Department, Kenya), field zoologist, Veterinary Department, Kenya; D. H. Rhodes (fisheries officer, Uganda), senior fisheries officer, Uganda; D. C. M. Corbett, plant pathologist, Nyasaland; D. L. Curtis, plant breeder (botanist), Nigeria; E. C. W. Dunham, agricultural officer, Sierra Leone; K. M. Harris, entomologist, Nigeria; G. C. H. Hill and N. K. Dale-Jones, agricultural officers, Kenya; T. E. O'Leary, agricultural officer, British Solomon Islands Protectorate; J. C. Phillips, agricultural officer, Uganda; D. L. Stacey, agricultural officer, Federation of Malaya; G. G. Williams, agricultural officer, Nigeria; R. E. Wyatt, plant pathologist, Nigeria; C. D. Burnside, surveyor, Nigeria; E. A. Stephens, geologist, Sarawak, North Borneo and Brunei; W. T. Dale, senior plant pathologist, West African Cacao Research Institute, Gold Coast; G. Fryer and T. D. Iles, scientific officers, Northern Rhodesia and Nyasaland Joint Fisheries Research Organization; J. Roffey, scientific officer (entomologist), East Africa High Commission; P. S. E. R. Dickens, veterinary officer, Uganda; M. B. Jacob and J. Prydie, veterinary officers, Kenya; I. McLaughlan, veterinary officer, Nyasaland; J. A. R. Blacking, assistant adviser on aborigines, Federation of Malaya; J. Bolton, chemist, Department of Science and Agriculture, Barbados; B. J. L. De Souza, D. E. Greenwood and D. W. T. Pedder, assistant conservators of forests, Northern Rhodesia; R. H. Kemp, assistant conservator of forests, Nigeria; A. W. S. Mould and M. F. Purnell, soil survey officers, Gold Coast; N. R. Quill, development officer, Agricultural Department, Somaliland Protectorate.

Announcements

THE Gold Medal of the Royal Astronomical Society has been awarded to Dr. Walter W. Baade, of the Mount Wilson Observatory, California, for his observational work on galactic and extra-galactic objects.

THE following appointments with effect from October 1 have been made in the Queen's University of Belfast: Dr. Alwyn Williams, lecturer in geology in the University of Glasgow, to the chair of geology; Dr. John Heslop Harrison, reader in botany in University College, London, to the chair of botany.

MR. H. FAULKNER, who has recently retired from the General Post Office with the rank of deputy engineer-in-chief, has been appointed director of the Telecommunication Engineering and Manufacturing Association. Mr. Faulkner has had a life-long connexion with telecommunications, having served for forty years with the Post Office; he has also been chairman of the South Midland Centre of the Institution of Electrical Engineers and, until recently, was a member of the council of that body.

APPLICATIONS are invited for the Helen Putnam Fellowship for advanced research, a postdoctoral resident fellowship for women, with research facilities at Harvard University. The research may be in any field related to human genetics or mental health, including psychology, child development and other fields of social science. The stipend will be 3,000 dollars a year, with possibility of renewal. Application forms, to be returned by April 1, and further information can be obtained from the Secretary of the Graduate School, Radcliffe College, Cambridge 38, Massachusetts.

THE Medical Research Council is offering a number of fellowships in clinical research, tenable in the United Kingdom during the academic year 1954–55, which are open to suitably qualified medical graduates who desire to prepare themselves for a career in clinical research. The fellowships will be awarded for one year in the first instance, renewable annually up to a maximum of three years, and will carry a stipend of £850 a year, plus superannuation, with annual increments of £75. Applications must be sponsored in each case by the head of the appropriate department in the candidate's university or medical school. Application forms can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, to whom they must be returned not later than March 1.

THE first and second parts of the fifth volume of *Ambix*, the journal of the Society for the Study of Alchemy and Early Chemistry, were published in October. They include a study by H. E. Stapleton of some previously unexplained features in the writings attributed to Jabir, an article by F. S. Taylor on the alchemist Hunyades, and several reviews.

POETRY AND SCIENCE

ON December 9, the P.E.N. (Poets, Playwrights, Editors, Essayists and Novelists) Club held an informal discussion on poetry and science. The participants were Prof. Herbert Dingle, professor of the history and philosophy of science, University College, London; N. W. Pirie, head of the Biochemistry Department, Rothamsted Experimental Station; G. S. Fraser, a poetic critic; and Stephen Spender, a well-known poet. The chairman was Kathleen Nott, a poet who has written about the subject under discussion.

At first sight it might appear that these branches of culture had little to do with each other. But Prof. Dingle gave instances of the antagonism between poets and scientists, and pointed out that the overt attacks arising from this antagonism in the past were made by the poets. This, he said, is understandable; at that time it was thought that there was a real external world, the truth about which was being increasingly found out by the scientists. To poets, this world seemed flat and distasteful, but at the back of their minds the uncomfortable thought grew that any alternative was mere illusion. In Prof. Dingle's opinion, however, there is no need for the poet to harbour such resentment. The philosophical background has altered; and with this alteration, the activities of poet and scientist appear compatible. Omar Khayyam compared the first appearance of light out of darkness to a flung stone, and to the noose of a rope. Scientists also have compared light to a moving particle, and to an agitated cord. Finally, they have settled down to an equation embracing both concepts; but it is nonsense to say that light is an equation. In fact, science is the organized description of the relations between experiences; poetry, the expression of the experiences themselves.

This description of the limits of science, abnegatory as it might seem, did not dispel the injured suspicion of the poets present. Stephen Spender, side-stepping Prof. Dingle and attacking Kathleen Nott, re-asserted the right of the individual to subjective knowledge of truth. He said that the psychologist may attribute the cause of conscience to infantile experiences; he himself might attribute it to God; what claim has science to the unique truth of the matter? Not only are the findings of science uncomfortable in detail; they are also so complicated that no one man can understand them, and increase of understanding brings with it disorientation and despair.

G. S. Fraser brought in some second-order corrections to complicate Prof. Dingle's neat separation of the subjects. The findings of science are themselves some of the experiences of the poet. Donne was aware of Copernicus, and this awareness brought on discomfort to which he gave poetic expression. The quality of exactness is not confined to science, for poetry has its own criteria of exactness. A difference between poet and scientist is that whereas one particularizes, the other generalizes.

N. W. Pirie broke down the icy rigidity which science is apt to assume in such discussions, and gave a warm and humorous description of the scientist at work. In a highly selected environment records of observations are made. These statements are no more dramatic in content than 'the cat sat on the mat'. Having puzzled over these statements, and discarded those he dislikes, the scientist begins to devise a theory (which must be generally plausible), and to shape it into a form acceptable for publication. The language of scientific publication, by a long-enforced tradition, is strangulated in the extreme; any poet could be excused for finding it repulsive—though the use of the word 'elegant' is permitted. But, said Mr. Pirie, let us turn from the first and last of these processes to the second; in the act of imaginative creation the poet is not far from the scientist.

Neither in the opening addresses nor in the general discussion did the representatives of science and poetry get to grips. Prof. Dingle renounced certain territorial claims, and thereby lowered the intracultural tension. But he discreetly omitted any reference to one defended area of science: that of attempted approximate consistency. Of course, it is absurd to say that light is identical with an equation. But the equation itself is (in the meaning of the words familiar to scientific men) true of light; and only by changing the frame of reference can we say that it is true of ripeness that 'ripeness is all'. The chorus of approval of Humpty-Dumpty's attitude to words obliterates the fact that his conversation with Alice, like much of this discussion, was inconclusive.

To comfort any class of humans, especially poets, is an amiable end. But the study of poetry from the viewpoints of anthropology, individual psychology or information theory has interested some poets and might increase the knowledge (if not the comfort) of more.

C. E. G. BAILEY

STUDY OF THE BRITISH FLORA DURING 1953

ADDITIONS to the knowledge of the British flora during 1953 have not included spectacular discoveries of the kind reported in 1951[1] and 1952[2], but the year has been marked by steady progress in many branches of research. The annual exhibition meeting of the Botanical Society of the British Isles, which was arranged in the lecture room of the British Museum (Natural History) on November 28, will be remembered for the close studies of small groups and demonstrations of new techniques rather than for the new species and hybrids to the British list, and extensions of range of previously known plants.

The technique used by P. F. Yeo (University of Cambridge) in his exhibit of wild and cultivated specimens from six populations of *Euphrasia nemorosa* was of particular interest. He has overcome the difficulty of growing this partial parasite under satisfactory standard conditions by raising plants in pots which each contained a single plant of *Plantago lanceolata* to serve as a host. The method might well be adapted for the study of other critical parasitic

groups. Miss W. T. M. O'Connor (University of Liverpool) demonstrated the analysis of a suspected hybrid population between *Centaurium minus* and *C. littorale*. An analysis of differentiating taxonomic characters similar to that suggested by Wilmott[3] for discriminating *Euphrasia* taxa has been carried out, and Anderson's well-known 'hybrid index' method has been used in investigating the population. The selected characters were scored in each individual plant according to their agreement with the putative parents or their intermediacy, and the numerical index for each obtained by a summation of the scores. The structure of the population was then summarized in a frequency distribution.

An excellent example of the way in which modern experimental methods can be used to confirm and explain earlier inferences based on taxonomic and field observations was shown in the exhibit by J. D. Lovis and Miss M. D. Shivas (University of Leeds) on the synthesis of *Asplenium* × *breynii*. This fern has been found wild in small numbers in various mountainous parts of Britain, and is a triploid hybrid (somatic chromosome number, 108) between submontane diploid *A. trichomanes* ($2n = 72$) and *A. septentrionale*, which is a tetraploid ($2n = 144$). During the past year, six plants of the hybrid have been raised by hybridization experiments carried out at the Department of Botany, Leeds, and one of the plants became fertile. S. Walker (University of Leeds) exhibited the range of forms of *Dryopteris austriaca* (*D. dilatata*). This is normally tetraploid ($2n = 164$), but on Ben Lawers a diploid ($2n = 82$) plant occurs which differs in the fine cutting of the frond and very unevenly deltoid basal pinnæ. It forms sterile (triploid) hybrids with the tetraploid form, and it was suggested that it deserves specific rank.

Dr. F. H. Whitehead (University of Oxford), by a biometric method of discriminant analysis[4], using seed size, pollen size, and ratio of length to breadth of petals, showed that all the British material previously referred to as *Cerastium subtetrandrum* fall within the variation range of *C. tetrandrum* and are not justifiably interpreted as belonging to the Swedish taxon described by Murbeck. D. R. Glendinning also showed work likely to remove a name from the British list; his exhibit demonstrated that the characters attributed to *Polygala oxyptera* are produced by the influence of exposed conditions on plants of *P. vulgaris*, and he suggested that it should be included in that species.

Other careful studies of small groups of British plants included those by Dr. E. W. Davies, Miss P. A. Padmore and Prof. T. G. Tutin (all of University College, Leicester) on the *Carex flava* aggregate, *Ranunculus flammula* from Orkney and Shetland, and *Carex* Section *Acutae*, respectively; from Dr. J. H. Burnett, Miss S. M. Littleboy and Dr. E. F. Warburg (University of Oxford) on *Veronica* Section *Beccabunga*, *Apium*, and *Sorbus*, respectively; from M. C. F. Proctor (University of Cambridge) on variation and cytology of *Helianthemum guttatum* and allied species, and Miss A. Wylie (University of Manchester) on the genetical structure of the Caninae roses. F. N. Hepper (Royal Botanic Gardens, Kew) provided an exceptionally well-displayed exhibit to illustrate how populations of *Silene nutans* in Britain have developed their own characteristics[5]. Herbarium and living material was shown from the various populations, with electric switches provided, by means of which the localities from whence the specimens were collected could be illuminated on a large map of England and Wales set up as a background.

New plants to the British list on exhibition included one critical 'split', three hybrids and three aliens. D. E. Allen (University of Cambridge) showed *Cardamine crassifolia* Pourr. (= *C. monticola* Timb. Lag.), which he identified from a herbarium specimen collected in 1892 in Nant Frangon, Caernarvonshire. J. E. Lousley exhibited *Senecio* × *viscidulus* Scheele with its parents, *S. viscosus* and *S. sylvaticus*, from Frensham, Surrey; this hybrid is likely to be rare in Britain as the two parents seldom occur together. J. D. Lovis (University of Leeds) showed a living plant of an *Arum* from Arundel, Sussex, which from its morphology and chromosome number ($2n = 69$ or 70) seems likely to be a hybrid between *A. maculatum* and *A. neglectum*, with which it is associated. N. Y. Sandwith (Royal Botanic Gardens, Kew) displayed plants of *Hypochoeris glabra* and *H. radicata* from Wonersh, Surrey, with a plant which had intermediate characters and sterile achenes, indicating that it was a hybrid.

The alien aquatic *Egeria densa* (Planch.) Casp. was exhibited fresh in a tank by Miss L. W. Frost with a map showing its distribution in a canal in south Lancashire. It is known to have been introduced by an aquarist and is now thoroughly established, though restricted to the warm water coming from a mill effluent. Miss V. Gordon showed *Epilobium linnaeoides* Hook. f. collected at Helsby, Cheshire, in 1938 and found well established for more than a mile west of Leenane, Co. Galway, in 1953. In view of the rapidity with which the allied *E. pedunculare* A. Cunn. has spread in remote parts of Britain, the progress of this recently discovered species will be watched with special interest. B. T. Ward and J. F. Shillito exhibited *Cuscuta australis* R. Br. subsp. *cesatiana* (Bertolini) Yunckner from Enfield, Middlesex, and Barking, south Essex, as a parasite on various weeds and on garden asters.

Two exhibits gave additional information about important recent discoveries in Scotland. Dr. H. Godwin (Botany School, Cambridge) showed a single pollen grain of *Koenigia islandica* from late-glacial deposits at Whitrig Bog, Berwickshire. This species was first reported for Britain as a living plant from Skye in 1950[6], and evidence of its occurrence in late-glacial times is therefore of special interest. J. E. Lousley exhibited photographs and specimens of *Artemisia norvegica* from the locality in north-west Scotland where it was recently discovered by Sir Christopher Cox[2]. Some important earlier discoveries, and plants which have been the subject of recent papers in *Watsonia*, were illustrated by a fine series of sheets of mounted specimens from the herbarium of the British Museum (Natural History), which also loaned important material to supplement other exhibits. Dr. A. Melderis showed some interesting grasses he collected on the Society's visit to Forres, including true *Poa laxa* from the Cairngorms which seems to have been misunderstood in Britain. Miss M. S. Campbell showed living and dried material of *Erophila conferta* from Essex[7] and Perthshire[8].

Extensions of range of species already known included Prof. D. A. Webb's (Trinity College, Dublin) discovery of *Erica mackaiana* in west Donegal; this is only known elsewhere in Connemara and northern Spain, and it is very unfortunate that the new locality is threatened by hydro-electric development of the lough around which the plant grows. R. A. Graham exhibited photographs, paintings and speci-

mens of *Epipogium aphyllum* from Buckinghamshire. Here he found more flowering spikes of this rare orchid in one season than had been found altogether in Britain in a century, and it also reappeared in 1953 in an Oxfordshire wood where it had been seen previously. P. M. Benoit showed specimens of *Hypericum undulatum* from Merioneth, where he found it in August 1951; this plant has hitherto been known only from Devon, Cornwall and Pembrokeshire, and the new locality is the most northerly recorded. Another important discovery from Wales is that of *Lotus hispidus* from Haverfordwest, Pembrokeshire, where it was found by F. W. Adams, who also showed *Carex punctata* which grew with it, as it frequently does elsewhere. Miss S. Hooper showed *Tillaea muscosa* from Surrey, from which county it has not been previously reported. A. C. Jermy had interesting maps and specimens illustrating the variation and extension of range of *Naias marina* since its first discovery in the Norfolk Broads in 1883, while Dr. D. Coombe (University of Cambridge) showed detailed distribution maps of four species of *Impatiens* in Britain, illustrating their present status and dates of first evidence.

An exceptionally ingenious exhibit by J. F. M. Cannon (British Museum (Natural History)) and Miss M. J. Herbert showed the epiphytic flora of some trees by a stream near Flatford Mill. Possible dispersal agencies were illustrated by models, and an analysis of frequency of occurrence in relation to dispersal mechanism had been carried out. Two unusual plants found as epiphytes were *Fagopyrum sagittatum*, believed to have come from a field sown with buckwheat the previous year, and *Parapholis strigosa* from a salt-marsh—the nearest being half a mile away. Dr. D. P. M. Guile showed a one-inch map of the whole of the Brecon Beacons National Park, coloured for the associations recognized in his ecological survey and accompanied by a book with photographs and accounts of the main ecological types.

Limitations of space prevent reference to the remainder of the exhibits, an account of which will appear later in the *Proceedings* of the Society. The meeting was attended by about two hundred and fifty members and guests. J. E. LOUSLEY

[1] Lousley, J. E., *Nature*, **168**, 934 (1951).
[2] Lousley, J. E., *Nature*, **171**, 335 (1953).
[3] Wilmott, A. J., *Proc. Linn. Soc.*, **162**, 31 (1950).
[4] Whitehead, F. H., *New Phyt.* (in the press).
[5] Hepper, F. N., *Watsonia*, **2**, 80 (1951).
[6] Burtt, B. L., *Kew Bull.*, 266 (1950).
[7] Wilmott, A. J., *Watsonia*, **1**, 137 (1949).
[8] Campbell, M. S., *Scot. Nat.*, **63**, 49 (1951).

CACAO RESEARCH IN TRINIDAD

REPORT FOR 1945–51

THE development of research on the cacao tree started late but has been rapid, thanks chiefly to the activities of two centres—the Imperial College of Tropical Agriculture in Trinidad and the West African Cacao Institute at Tafo, Gold Coast. The Imperial College gave attention to cacao problems from its inception in 1922, and a small research scheme was established there in 1930, on which reports were published annually up to 1944. The scheme was expanded in 1947 and now employs eleven research workers, being financed jointly by the United Kingdom Government (under the Colonial Development and Welfare Act) and the Cocoa, Chocolate and Confectionery Alliance, Ltd. (representing the chocolate manufacturers of the United Kingdom).

The first report on the post-war phase of the research, which has recently been issued*, comprises twenty-seven technical papers under five headings and is summarized in an introduction by H. J. Page.

Selection, breeding and propagation. The wide variation between individual trees in the seedling cacao population of Trinidad estates suggested early attention to selection and vegetative propagation, with the dual object of providing improved planting material for the grower and genetically uniform trees for the research worker. A technique for rooting cuttings was found, and from 1937 onwards clonal trials were planted, in which each clone was represented by some trees on their own roots and some propagated by budding on seedling rootstocks. F. W. Cope reports in detail on the results of these trials up to 1951. In spite of careful initial selection, only about one in three of the clones has given heavy yields; but the best are very good and "may confidently be expected to yield several times as heavily as unselected material". The good clones have all performed better on their own roots than on seedling rootstocks; some of the poor clones yielded more as buddings.

Now that a number of clones have been established and tested, attention is shifting to the combination of desirable characters in new genotypes; and crosses have also been made to throw light on the genetics of self-sterility in cacao. A collection of cacao types and *Theobroma* species is being steadily built up, and since the report was written an expedition has been collecting in Colombia along the tributaries of the Upper Orinoco and Amazon.

H. Evans describes recent investigations on the propagation of cacao. The technique for rooting cuttings has been much improved by his detailed analysis of the physiological factors controlling the process. The results are of practical value as well as scientific interest, because the use of cuttings as commercial planting material is spreading. In Trinidad alone the annual nursery production is now of the order of a quarter of a million plants, and large numbers are raised in some other countries.

Soils and nutritional factors. Papers are included on the deterioration of cacao soils in Trinidad (F. Hardy) and on the results of a mulching experiment carried on for ten years (T. E. Wasowicz and G. Havord). Soil deterioration under cacao is a common problem wherever the crop is grown, and particularly where it is grown on marginal soil types. It is marked by changes in the organic surface layer, and sometimes by an actual truncation of the soil profile as a result of erosion. The first essentials for renovation are to re-establish crumb structure in the surface layer and to raise the level of available nutrients. Striking results have been obtained by mulching, but at high costs which further research may lessen.

Three papers by H. Evans and others dealing with the mineral nutrition of cocoa are of outstanding interest. Some of the diagnostic methods found useful elsewhere for determining mineral deficiencies

* A Report on Cacao Research 1945–51. Pp. 132. (Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I., 1953.) 25s.

and toxicities in other crops have been adapted to cacao, and symptoms have been produced in sand and water cultures. The description of these symptoms by E. J. Maskell, H. Evans and D. B. Murray, illustrated by fourteen colour-plates and numerous half-tone reproductions, will be a standard work of reference. Indications were found that micro-element deficiencies are common in cacao in Trinidad and other West Indian islands, and curative methods are being developed.

Other environmental factors. As cacao is commonly grown under shade, it is good to see that a critical investigation of the effects of shade on growth has been started, on which a progress report is presented by H. Evans and D. B. Murray. Preliminary findings are that optimum light intensity for young cacao in the first year lies between 25 and 60 per cent of full sunshine; there is evidence that the optimum increases with size of plant and consequent self-shading; the effect of fertilizers is less marked at low than at high light intensities; and there are differences between clones in behaviour under the various treatments.

Pests and diseases. R. E. D. Baker reviews briefly research on witches' broom disease (*Marasmius perniciosus* Stahel). Locally selected clones vary widely in their susceptibility to this disease, though none is immune. Immune or very highly resistant material from the Upper Amazon is being used in the breeding programme.

T. W. Kirkpatrick gives an account of the insect vectors of a Trinidad cacao virus. This virus, though less destructive than the most virulent strains of swollen-shoot virus in West Africa, appreciably reduces yield and is under close study.

Preparation and quality of cocoa. Quality is determined by genotype, growing conditions and the preparation (fermentation and drying) by which fresh cacao beans are converted into the 'raw cocoa' of commerce. The first two are field factors governing the composition of the fresh seeds as harvested; their interactions can be studied by using clonal material. F. Hardy, G. Rodrigues and F. Haworth describe variations in nitrogenous components of the bean as influenced by genotype, soil type, age of tree, season and environment. This work is a useful start in a field where much more is needed.

The microbiology and biochemistry of the changes occurring during fermentation and drying are likewise vast fields of research which have only recently been entered. Some preliminary work on the enzymes of cocoa tissue by K. W. De Witt should be useful in this connexion. The same author describes apparatus for small-scale fermentation, which is an attempt to solve one of the most urgent short-term problems in cacao research to-day. New varieties produced by the plant breeders, however good their agricultural performance, cannot be recommended for commercial planting until it is ascertained that they will suit the chocolate manufacturer as well as the grower; but so far it has proved impossible to assess quality satisfactorily from samples prepared on a small scale, and time, land and effort have to be wastefully expended in multiplying trees to produce large bulks of seeds for tests. Full explanation of the differences between large and small bulks in fermentation may take long to get; but a technique for judging quality from small samples, however empirical, must be found soon if progress is not to be halted.

E. E. Cheesman

FORESTRY RESEARCH IN GREAT BRITAIN

THE report by the Forestry Commission on forest research in Great Britain for the year ending March 1951* is divided into two parts: the work carried out by the research staff of the Forestry Commission; and research undertaken on behalf of the Commission by universities and other institutions. In an introduction by James Macdonald, director of research and education, it is noted that forestry research has to be undertaken in branches outside the purely scientific. Last year a section dealing with mechanization of forestry operations was formed. With an advisory committee having been set up on the utilization of home-grown timbers during the year under review, a new section was established to carry out investigations into the marketing and utilization of produce from woodlands in Britain. This new section will keep in touch with the Forest Products Laboratory at Princes Risborough. There were no major developments in sylviculture, but a summary is given in the report of interesting work on the natural regeneration of the old Scots pinewoods in the Highlands; and another article is on the use of larch in mixture in the formation of oak plantations, a subject which has been studied in the south of England for a number of years—in fact, with the example extant in the Forest of Dean, for nearly a century. A point of interest is the survey of plantations which had been formed on old ironstone workings in the Midlands, on which a further report is awaited. The research station at Alice Holt, which has already outgrown its capacity, has been equipped for seed-testing, and the Commission's stocks of seed are already being tested there. A considerable amount of experimental work was carried out in connexion with forest nurseries. It is perhaps open to doubt whether the reclassification of derelict woodland areas recorded in the census of woodlands for the south-east and south-west conservancies of England yet gives the true picture of their real position.

The thirty-third annual report of the Forestry Commission gives the record of the activities of the Commission for the year ending September 30, 1952†. The report opens with a tribute to the late Lord Robinson, chairman of the Commission, who died on September 5, 1952. As technical commissioner during 1919–32 and chairman for the past twenty years, Lord Robinson played a great part in organizing the Forestry Commission and shaping its policy, and his death is a great loss to British forestry.

Under the heading "General Review", the report deals with the stress laid by the Chancellor of the Exchequer on the need for economy in national expenditure. Foresters who have served in various forest services in the British Commonwealth have all had experience of this call from the financial minister; one of the first blows has often fallen upon the forest department, with consequences—not fully appreciated, it is admitted—which resulted in delaying progress. The Commissioners have closely reviewed their present, as well as their future, commitments. To a large extent these commitments are connected

* Forestry Commission. Report on Forest Research for the Year ending March 1951. Pp. vi+139+4 plates. (London: H.M.S.O., 1952.) 4s. 6d.

† Forestry Commission. Thirty-third Annual Report of the Forestry Commission for the Year ended September 30th, 1952. Pp. 90. (London: H.M.S.O., 1953.) 3s. net.

with the expanding programme begun in 1945. The progressive increase in the area planted, from 26,000 acres in the forest year 1947 to more than 61,000 acres in the year covered by the present report, has involved increases in nursery ground and plant stocks and housing accommodation. The steady progress in the Dedication Scheme involves a higher outlay, while on the administration side the Forestry Act of 1951 places extra duties in connexion with felling licences on the staff, and the Commission has to face the rise in wages of forest workers. Reduction in expenditure was therefore by no means an easy task.

The Commissioners have been guided by two considerations: first, the maintenance, tending and protection of existing woods must have priority—an obvious necessity; secondly, every endeavour will have to be made to maintain the present rate of planting, in order to avoid waste and the sacrifice of nursery stock, and the rate of the preparatory work, fencing, ploughing, draining, etc., already undertaken or in progress. Economies will be made in housing, road development, staff cuts and general administration.

In spite of these troubles, the existing forestry estates have been maintained, and, as already noted, an area of 61,000 acres has been planted during the year. Of this area, 22,000 acres (36 per cent) consisted of replanting, that is, restocking felled or devastated woodland or scrub—a most meritorious piece of work and the highest proportion yet reached. As one result of the thirty years of planting, it was possible to increase by 4,400 acres the area thinned in the plantations, the greater part of the increase being in Scotland; this is the beginning of a return on the expenditure already incurred. Progress in private forestry is reported on favourably, and the Dedication Scheme is said to be making substantial headway.

The disastrous 'windblow' in Scotland during the end of December 1951 and the middle of January 1952 is dealt with at some length. The Commission's plantations escaped comparatively lightly, the timber blown over on scattered small areas amounting to about 300,000 cubic feet. The windfall on private estates amounted to nearly four million cubic feet of timber, there being cases in Sutherland and Caithness of whole woods being laid flat. All species suffered, including Scots pine and oak and other broad-leaved species.

The report shows that the Commission can claim to have already laid the foundations in Britain of a forestry estate which, under correct management, will prove of inestimable value to the country. Correct perpetual management involves working plans, and on the subject of such plans the Commission almost appears to suffer from a slight inferiority complex. The report admits that "the forest working plan is essentially a document which describes the existing tree crops and the conditions under which they are growing, which specifies in more or less detail the work to be carried out during the period of the plan, and which provides for records to show what progress has been made". It is the intensity upon which the plan is made that is the obstacle. Because, in the case of long-managed and -regulated existing forests, the working plan is elaborate and made for ten or more years, it is difficult to understand why "the professional forester should regard only the complete, text-book type of plan as worthy of the name". What is the text-book type? It is obvious that such plans would be out of place and could not, in fact, be made for the large areas of young forests of the Commission. But simple plans for a short period of years are comparatively easy to make and work, and these are fully entitled to the name of working plan. They are not merely plans of operations—these latter contain prescriptions which can be modified almost at will; but prescriptions laid down in the working plan, once sanctioned by the highest authority, can only be modified or altered by that authority.

E. P. STEBBING

STERIC EFFECTS IN THE ELECTRONIC SPECTRA OF ORGANIC COMPOUNDS

By DR. E. A. BRAUDE, DR. F. SONDHEIMER* and DR. W. F. FORBES†

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PROFOUND changes in the ultra-violet light absorption of organic molecules due to substituents (such as methyl groups), the effects of which must be predominantly steric rather than electronic, were first noted by Pickett[1] and by Rodebush[2] in the case of diphenyls and acetophenones[3]. Many other examples have since been described and this phenomenon has been associated, in general terms, with spatial interference which opposes the adoption by the chromophoric system of the uniplanar arrangement required for most effective conjugation. In a more detailed discussion[4], a distinction was drawn between two different types of spectral manifestations of steric inhibition of uniplanarity: (1) steric effects which only cause a change in the absorption in intensity (that is, transition probability) of the band characteristic of the whole chromophoric system, but no unusual change in wave-length; (2) steric effects which cause a change in both wave-length (that is, transition energy) and absorption intensity. It was concluded that effects of type (1), which are encountered less frequently, occur when steric inhibition is comparatively weak; whereas effects of type (2), which are rather more common, occur when steric inhibition is comparatively strong.

The physical interpretation of the second type of steric effect is fairly clear; steric inhibition of electronic interaction normally raises the energy-level of the excited state more than that of the ground-state, thus increasing the transition energy and resulting in a hypsochromic shift of the band and an attendant change in intensity. On the other hand, the physical interpretation of the first type of steric effect is much less obvious. The absence of unusual wave-length displacements means that the separation of the energy-levels of the ground- and excited-states is almost unaffected by the substituent and, since the nature of the transition is evidently unaltered, the transition moment associated with any individual absorption act must also be unchanged; yet the macroscopic transition probability is reduced. Such a phenomenon is not inherent in classical theory and requires the postulate of a new principle. It was suggested[4] that steric effects of

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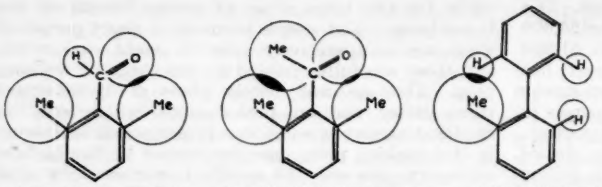

2 : 6-Dimethylbenzaldehyde 2 : 6-Dimethylacetophenone 2-Methyldiphenyl

Fig. 1

type (1) are due to a restriction of the transition to vibrational states allowing of a high degree of uniplanarity. A more precise interpretation, based on a re-examination of the ultra-violet light absorption of alkylated acetophenones and related compounds, will now be given which indicates that steric effects of type (1) are due to a restriction of the transition to vibrational states allowing of a high degree of uniplanarity in the excited state. Steric effects of type (1) may therefore be associated with transitions between non-planar ground-states and planar excited states, whereas steric effects of type (2) are to be associated with transitions between non-planar ground-states and non-planar excited states.

Acetophenone exhibits an intense band near 2400 A. which also appears in benzaldehyde and is due to an allowed transition of the benzoyl chromophore, which can be represented by $Ph—C=O \rightarrow Ph^{+}=C—O^{-}$. Methyl substituents cause only the usual small wave-length displacements ($\Delta\lambda \sim 50$ A.). In the benzaldehyde system, these are unaccompanied by any pronounced changes in intensity, although closer inspection reveals that, whereas *m*- and *p*-methyl groups cause a small increase in ε, *o*-methyl groups produce a small but definite decrease. In the acetophenones, *m*- and *p*-methyl groups also cause small increases in ε ($+ \Delta\varepsilon$ *c.* 1,000), but *o*-methyl groups produce very marked decreases in ε (see Table 1). The ratios of the observed ε to that (ε_0) expected on the assumption that, in the absence of a special '*ortho*-effect', *o*-methyl groups would increase ε by a similar amount as in other positions, range from 0·8 to 0·2. Analogous effects are observed in the corresponding acetyl*cyclo*hexenes, where matters are complicated, however, by the non-equivalence of the two '*o*'-positions[4,5]. The differences between the aldehydes and ketones are undoubtedly due to the fact that, whereas steric overlap between *o*-methyl groups and the aldehyde–hydrogen atom or carbonyl–oxygen atom is slight, interference between the *o*-methyl groups and the keto-methyl group in a uniplanar configuration is appreciable, as indicated by projection diagrams (Fig. 1). The repulsion energies may be estimated from potential energy curves to be of the order of 1–3 kcal./mol.

Now, absorption in the near ultra-violet corresponds to transition energies of the order of 100 kcal./mol., and changes of about 1 kcal./mol. will cause wave-length displacements of less than 50 A. On the other hand, increments of 1 kcal./mol. are of the same order as the spacings of the vibrational levels of a polyatomic molecule. In the ground-states of the hindered acetophenones, the levels of the torsional vibration about the Ph—CO link will be of the type indicated in Fig. 2, giving a preferred angle θ_1 between the planes of the phenyl and carbonyl groups such that $0 < \theta_1 < 90°$. In the excited state, in which the double-bond character of the Ph—CO link is greatly increased owing to larger contribution from $Ph^{+}=C—O^{-}$, the preferred interplanar angle of the torsional levels will have a smaller value θ_2 ($\theta_2 < \theta_1$). Since θ cannot change during an electronic transition (Franck–Condon principle), only those ground-state molecules in which $\theta \simeq \theta_2$ will be able to undergo the transition. The fraction (r) of molecules fulfilling this condition will, on the simplest possible assumptions, be given by $\cos(\theta_1 - \theta_2)$. If the further assumption (which will be justified later) is made that $\theta_2 \simeq 0$, that is, that the chromophore must be almost truly uniplanar in the excited state, then $r \simeq \cos\theta_1$. But r is also given by $\varepsilon/\varepsilon_0$, where ε_0 is the value for the unhindered compound ($\theta_1 = 0$). Hence,

$$\cos\theta_1 \simeq \varepsilon/\varepsilon_0. \qquad (1)$$

The values of θ_1 derived in this way are shown in Table 2 and indicate that, in the acetophenone system, one *o*-methyl group results in a mean interplanar angle of about 50°, and two such groups in an angle of about 75°, between the phenyl and carbonyl groups in the ground-state. If $\cos^2\theta$ instead of $\cos\theta$ functions are used[6], the derived values of θ are reduced by 10–15°.

If these conclusions are correct, they should be borne out by other physical properties strongly influenced by electronic interaction. In Table 2, the

Table 1

	$\lambda_{max.}$ (A.)†	ε	$\varepsilon/\varepsilon_0$
Benzaldehyde	2420	14,000	1·00
4-Methyl-benzaldehyde	2510	15,000	1·00
2-Methyl-benzaldehyde	2510	13,000	0·87
2 : 6-Dimethyl-benzaldehyde	2510	12,500	0·78
2 : 4 : 6-Trimethyl-benzaldehyde	2640	14,500	0·85
Acetophenone	2420	13,000	1·00
4-Methyl-acetophenone	2520	15,000	1·00
2-Methyl-acetophenone	2420	8,500	0·58
2 : 4-Dimethyl-acetophenone	2510	13,000*	0·76
2 : 5-Dimethyl-acetophenone	2450	10,000	0·59
2 : 6-Dimethyl-acetophenone	2510	5,500	0·32
2 : 4 : 6-Trimethyl-acetophenone	2420	3,500	0·18

* Our data for this compound are in better agreement with those reported in ref. 2 than in ref. 3. † Hexane or ethanol solutions.

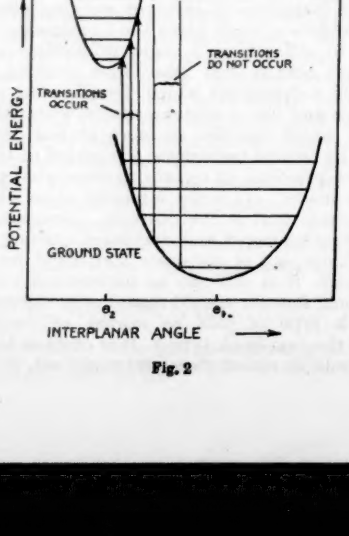

Fig. 2

Table 2

	$\mu_{obs.}$ (D.) (ref. 6)	μ_0 (D.)	θ_1*	θ_1†
Acetophenone	2·96	2·96	0°	0°
2-Methyl-acetophenone	—	2·86	—	41°
2 : 4-Dimethyl-acetophenone	2·95	3·13	58°	35°
2 : 5-Dimethyl-acetophenone	2·85	2·96	61°	54°
2 : 6-Dimethyl-acetophenone	—	2·96	—	71°
2 : 4 : 6-Trimethyl-acetophenone	2·81	3·03	78°	80°

* Calculated from μ by equation (2).
† Calculated from ε by equation (1).

dipole moments of acetophenones observed by Sutton and co-workers[7] are given, together with those (μ_0) calculated on the following basis: (i) the moments are compounded of group moments of $\overset{+\longrightarrow}{C{=}O}$ (taken as 2·96, the value for acetophenone) and $C_6H_4\overset{\longrightarrow+}{—}Me$ (taken as 0·40), (ii) the vector addition is done assuming all C—C—C bond angles to be 120°, (iii) in unsymmetrically substituted structures, the two possible coplanar forms are given equal weight. The interplanar angle θ_1 is given by:

$$\cos\theta_1 \simeq (\mu_{obs.}-\mu_{90})/(\mu_0-\mu_{90}), \qquad (2)$$

where μ_{90} is the moment for the completely deconjugated system ($\theta_2 = 90$), taken to be the same as that of a saturated ketone (2·75, the value for acetone). For the three compounds for which both spectral and dipole moment data are available, the values of θ_1 derived in this way are in reasonable agreement, considering the approximations made and the sensitivity of expression (2) to uncertainties in μ. Since dipole moments are conditioned by the molecular ground-states alone, this supports the assumption made above that $\theta_1 \simeq 0$. No experimental dipole moment has been recorded for 2-methyl- or 2 : 6-dimethyl-acetophenone, but the interplanar angles derived from spectral data lead to predicted values of 2·81 and 2·82, respectively, for these two compounds under the conditions employed by Sutton *et al.*[7].

It is instructive to compare the acetophenone system which gives rise to steric effects of type (1) with the diphenyl system which gives rise to steric effects of type (2). Diphenyl exhibits a band near 2500 A. ascribed to a transition characteristic of the diphenyl chromophore representable by Ph—Ph → $^+$Ph=Ph$^-$. The introduction of one *o*-methyl or other *o*-alkyl group not only decreases the intensity of the band but also produces a very marked hypsochromic shift to about 2350 A., while the introduction of two *o*-methyl groups results in the complete disappearance of the band (Table 3). Thus the spectral consequences of steric effects in diphenyl and acetophenone differ profoundly, and yet the relevant portions of the two systems are remarkably similar structurally (Fig. 1). If our earlier conclusions are correct, the differences in spectral behaviour should be due to the fact that steric opposition to uniplanarity is much stronger in the *o*-substituted diphenyls than in the acetophenones, despite the superficial resemblance in geometry.

It is easy to see that this is indeed the case. In the acetophenones, interference is between an *o*-methyl substituent and the hydrogen atoms of the keto-methyl group; since there is little hindrance to rotation about the CO—CH_3 bond, the hydrogen atoms can take up relatively favourable positions such that one is above and one below the plane of the conjugated system on the near-side of the ring, and cause least interference with the hydrogen atoms of the *o*-methyl substituent. In the diphenyls, on the other hand, interference is between an *o*-methyl substituent and an *o'*-hydrogen atom of the other ring; since the ring-hydrogen atom is held rigidly in the plane of the conjugated system, it will cause maximum interference with the *o*-substituent. It may be estimated that steric repulsion to uniplanarity due to an *o*-methyl substituent in the diphenyl system is of the order of at least 10 kcal./mol., that is, several times as great as in the acetophenone system.

Table 3

	$\lambda_{max.}$ (A.)	ε
Diphenyl	2490	14,500
2-Methyl-diphenyl	2370	10,500
2-Ethyl-diphenyl	2330	9,000
2-*n*-Butyl-diphenyl	2330	9,000
2 : 2'-Dimethyl-diphenyl	< 2200 (ref. 2)	—

More extensive data and a fuller discussion of these ideas and their application to other examples will be presented elsewhere. Grateful acknowledgment is made to the Department of Scientific and Industrial Research for a senior award to one of us (F. S.), and to the Ministry of Education for an F.E.T.S. Grant to another (W. F. F.), during the tenures of which the experimental work was carried out. [Oct. 6.

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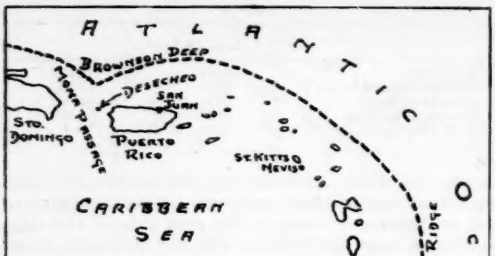
SUBMARINE LANDSLIPS OFF THE COASTS OF PUERTO RICO AND BARBADOS, WEST INDIES

By RAOUL C. MITCHELL

DURING the twelve-month period December 1951–52, unusual sea conditions were experienced along the coasts of Puerto Rico and Barbados, West Indies. On December 2–3, 1951, very rough surf occurred along the northern coast of Puerto Rico and the western coast of Barbados. Again, on December 5, 1951, heavy seas pounded the western coast of Barbados. During the morning of December 2, 1951, the seas were calm along the northern Puerto Rican coast; but shortly after noon a rapid agitation of the seas was noticeable, and by 3 p.m. local time mountainous waves lashed the coasts. The entire day was calm and sunny, and the mildness of the weather contrasted impressively with the wildness of the seas. Similar calm weather prevailed during the high seas in Barbados. In both islands, there was considerable damage to houses, roads and small fishing craft.

In Puerto Rico, the San Juan Magnetic Observatory records microseism amplitudes on horizontal seismograms. For the entire period of December 2–3, 1951, amplitudes lower than average were recorded. The



Observatory at Fonds St. Denis, Martinique, records near tremors, but it is not possible to determine exactly the foci. For the date in question, the Observatory recorded four tremors with epicentres some 120–560 km. distant. In both Puerto Rico and Barbados the onset of the heavy seas was very sudden, and so presumably the cause must have occurred near the time of onset. The times of origin of the tremors recorded at Martinique do not agree with the times of the heavy seas in these two islands. Further, the tremors recorded at Martinique were supposed to have originated east of the Lesser Antilles, whereas only the western Barbadian coast and northern Puerto Rican coast experienced stormy seas. For December 5, 1951, neither of these Observatories registered any tremors.

On August 17, 1952, I was marooned for twelve hours on the small, uninhabited island of Desecheo, some fifteen miles off the north-west coast of Puerto Rico. Suddenly, at about 4.30 p.m. local time, the sea withdrew along the western coast, sea-level being lowered perhaps 10 ft. There was a dull, muffled sound, followed by a remarkably rapid churning of the seas towards the west-north-west. Three hours later, seas were still very high, and it was next morning before I could be brought from the island. It was very warm, sunny and balmy all day. Later, it was discovered that rough seas had occurred along both coasts of Mona Passage.

For this date the San Juan Observatory recorded practically minimum microseismic activity, and nothing unusual was recorded in Martinique. A very strong earthquake took place on that day in Tibet, but it is unlikely that it could have been the cause of such purely localized sea conditions.

During December 3–4, 1952, exactly one year later, high surf again occurred along the north-east and north-west coasts of Barbados. Weather conditions were perfectly normal for the time of year. In Puerto Rico no such event took place, but the San Juan Observatory recorded very strong microseismic activity on December 3, 4 and 5, 1952. On December 2, 1952, Martinique registered small tremors from an epicentre calculated as some 385 km. distant, but the high seas of Barbados occurred thirty hours later.

Only one submarine earthquake occurred relatively near at hand on any of the above dates, namely, on December 5, 1951, epicentre some 335 km. south of Panama. No unusual sea conditions were reported along the Pacific coasts of Costa Rica, Panama or Colombia.

A study of synoptic weather maps of the North–South Atlantic and Caribbean Sea for the above dates rules out the possibility of the rough seas being attributed to meteorological conditions. If storms of rapid development, perhaps even too rapid to have been recorded on synoptic charts, were the cause, then it is strange that the wild seas were such localized occurrences. A detailed check has shown that on and about the above dates no other West Indian island nor even the neighbouring mainlands recorded unusual seas.

M. Molard, director of the Observatory at Martinique, also noted very stormy seas along the west coast of that island in 1939. He is emphatic in stating that the phenomenon was not due to meteorological conditions, and while such seas occurred during periods of local seismic activity, there was no direct correspondence between the events.

There is no indication of submarine volcanic activity being the cause. The preliminary withdrawal of the seas in the case of the Desecheo occurrence is, moreover, inconsistent with such an interpretation.

It would appear that it was neither earthquakes, meteorological storms nor submarine volcanoes which were responsible for these peculiarly localized phenomena along the coasts of the islands mentioned. The effect was purely local and a local cause must be sought.

Some ninety miles north of Puerto Rico is the Brownson Deep, the greatest depth so far discovered in the Atlantic. Barbados lies on the Barbados Ridge, the southern continuation of the Brownson Trough. The axis of the negative gravity anomaly strip passes through the Trough and Ridge and skirts Barbados only a mile or two west of the island. The region overlying the strip—the tectogene of Kuenen—is characterized by instability. Recognizing such instability, but excluding the above-mentioned possible causes, there seems one explanation available, namely, submarine landslips.

Just north of Desecheo, the Brownson Deep sends a tongue of deep water southwards towards Mona Passage. The slopes down into this tongue average about 13°. Ten miles out from Barbados, the slopes are about 3° to the west and 6° to the east. Submarine landslides in the past have been suggested by Hess[1] for the Barbadian mud-flows of the Upper Eocene Joes River formation, consisting of large sandstone blocks in a silty matrix. He thought the formation showed a strong resemblance to the submarine landslide outcrops of Quebec City, described by Collet, Bailey and Field[2]. The studies of Jukes-Brown and Harrison[3] and Gregory[4] on Barbados have shown that extraordinary vertical oscillations have taken place, and Trechmann[5] has likewise emphasized the "mountain-building in embryo" character of the island. Senn[6] has remarked upon falls of volcanic ash from the nearby volcanoes of Mt. Pélé in Martinique and Soufrière in St. Vincent being incorporated in the Oceanic beds of Barbados.

From the point of view of slope stability, the steep slopes north of Desecheo must naturally be viewed with suspicion. The well-known studies of Heim[7] in the Zugersee, Switzerland, and the work of Reyer[8] indicate that waves, increment of load, subsequent emplacement of coarser detritus on finer and lowering of the level of the waters, can each account for

submarine slips, and, further, such slides can occur on slopes of even less than 2°.

Referring to the slopes near Desecheo, the increment of loosely consolidated material washed down from the neighbouring lands of Santo Domingo and Puerto Rico would cause an increase in load. Creep would begin, and when enough momentum had been gained, a large mass or volume of sediments would suddenly detach itself and slide down the steep slopes.

In the case of Barbados and Martinique, it is presumed that falls of coarser volcanic ash upon finer sediments not only increases the load but also results in a change in distribution of stresses. This upsets the equilibrium, resulting in submarine slides.

Unconsolidated mass movement would not cause the sudden shocks associated with elastic rebound in earthquake phenomena. It is thus possible for such slides to be undetected at seismological stations. The volume of sliding material must have been enormous to cause such stormy seas. The energy of the waves would be dissipated within a relatively short distance, due to the immeasurably greater volume of the seas and the extremely localized nature of the phenomena, and so only adjacent coasts felt the effects of the agitated seas.

The simultaneous occurrence of high seas on December 2–3, 1951, at Barbados and Puerto Rico must be considered as purely coincidental.

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CHROMATOGRAPHIC SEPARATION AND ANALYSIS OF MIXTURES OF PYRUVIC, OXALACETIC AND ALPHA-KETOGLUTARIC ACIDS

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A NUMBER of workers[1–4] have published methods for the analysis of mixtures of α-keto acids in biological extracts, based on the chromatographic separation of the 2 : 4 dinitrophenyl hydrazones and the colorimetric estimation of the separated hydrazones. An attempt to use one of these methods[1], for the analysis of the α-keto acids present in enzymic digests, led us to the discovery that each of them could give rise to two stereo-isomeric hydrazones which did not give identical colour reactions in dilute sodium hydroxide. Previous workers[2,3,5,6] had noticed that pyruvic acid gave rise to a second hydrazone, but since this was usually small in amount, it had been generally ignored; only Seligson and Shapiro[3] had realized the importance of estimating both hydrazones. The fact that the α-keto acids examined could produce two isomeric hydrazones was not clearly recognized, and the object of the present study has been to modify the method of Cavallini, Frontali and Toschi[1] in order to eliminate the uncertainty which arises as a result of the discovery that stereo-isomeric hydrazones are formed.

Conversion of α-keto acids to 2 : 4 dinitrophenyl hydrazones. The reaction conditions employed were designed to ensure a complete conversion of the α-keto acid to the hydrazone with the minimum decomposition of the hydrazone. In the preliminary investigations, a 0·005 *M* solution of 2 : 4 dinitrophenyl hydrazine in 2 *N* hydrochloric acid was used, but was later replaced by a 0·01 *M* solution in 0·2 *N* hydrochloric acid in ethanol. The alcoholic solvent is preferable because the hydrazones of the α-keto acids are more soluble in it, and the final concentrations can be higher without any of the hydrazones crystallizing out. The higher concentration is advantageous in the subsequent chromatographic separation. The 2 : 4 dinitrophenyl hydrazine can also be dissolved in glacial acetic acid, in which the α-keto acid hydrazones are even more soluble than in alcohol. The general procedure in the case of enzymic digests was as follows.

0·1-ml. aliquot of an aqueous solution (concentration of α-keto acids not higher than 0·025 *M*) was added to 0·5 ml. of the solution of 2 : 4 dinitrophenyl hydrazine, at least two equivalents of the hydrazine being present in the final mixture. The reaction was allowed to proceed at 25° C. for 30 min. and then the solution was centrifuged to remove any denatured protein. The clear solution was examined on the paper chromatogram.

Chromatographic separation of the hydrazones. These were separated on paper chromatograms, the apparatus and general conditions of development being substantially the same as those described for the phosphate esters[6], except that a 50-μl. aliquot of the solution of hydrazones (equivalent to 2–20 μgm. of the α-keto acids) was applied as a streak 2·5 cm. long in order to obtain sufficient material for the final colorimetric estimation. With the solvents used in the present study, the greater part of the excess hydrazine in the solution runs at the solvent front and does not interfere with the separation of the hydrazones. The results obtained with the two solvent systems recommended are given in Table 1.

Table 1. MOVEMENT OF THE 2 : 4 DINITROPHENYL HYDRAZONES OF PYRUVIC, OXALACETIC AND α-KETOGLUTARIC ACIDS ON A PAPER CHROMATOGRAM (WHATMAN NO. 3) AT 20°

α-Keto-acid hydrazone		Distance run (cm.) with: *tert.*-amyl alcohol 65*, *n*-propanol 5, conc. ammonia 30 vol.; unbuffered paper; developed 12 hr.	Distance run (cm.) with: *tert.*-amyl alcohol 65*, ethanol 10, water 40; unbuffered paper; developed 24 hr.	Distance run (cm.) with: *tert.*-amyl alcohol 50* (ref. 5), ethanol 10, water 40; buffered paper†; developed 12 hr.
Pyruvic	3	3·4	—	4·3
	2	11·5	—	12·5
	1	17·5	—	17·0
Oxalacetic	2	3·9	6	3·7
	1	3·9	6·25	5·5
α-Keto-glutaric	2	3·5	5·3	4·7
	1	20·0	—	8·5
2 : 4 Dinitro-phenyl hydrazine		13·5‡	—	24·0
		25·0	—	—

* Solvent used, composition in volumes.
† Paper dipped in 0·05 *M* phosphate buffer (*p*H 8·0) and air-dried.
‡ This is the slowest-moving decomposition product and is present usually in small amount.

Pyruvic acid gives three hydrazones, the slowest of which is due to a polymer and can be almost completely eliminated if the pyruvic acid is distilled *in vacuo* just before use. α-Ketoglutaric acid gives only the slower-moving hydrazone under the standard reaction conditions described above. To obtain two hydrazones it is necessary either to heat the reaction mixture at 70° for 5 min. or to allow it to stand at room temperature for several hours. Oxalacetic acid gives four spots, two of them, representing approximately 3 per cent of the total hydrazones, being the pyruvic hydrazones produced by decarboxylation of the oxalacetic acid hydrazones. Longer treatment increases the proportion of the pyruvic hydrazones.

The solvent systems used in the present study would not separate the hydrazones of the three α-keto acids on one paper. In cases where the three α-keto acids were present, the procedure adopted was to estimate the pyruvic acid hydrazones on a buffered paper and to estimate the dicarboxylic acid hydrazones separately, using the ammonia solvent system. The figure for the sum of the two pyruvic hydrazones in the latter solvent would be unreliable, because there is evidence that they are slowly decomposed in the presence of ammonia to give brown products which run well ahead of the two hydrazones.

Recently, our attention had been directed by Dr. H. Wager (private communication) to the fact that the hydrazones of the three α-keto acids can be separated on a paper which has been dipped in 0·2 *M* phosphate buffer (*p*H 6·2) and air-dried and then developed for 17 hr. with the solvent described in Table 1 for buffered paper. The hydrazone of α-keto glutaric acid runs more quickly than those of oxalacetic under slightly acid conditions, whereas under alkaline conditions the reverse is true. At *p*H 7 they run together, but at *p*H 6·2 a good separation is obtained, with approximate R_F values for pyruvic (1, 2, Table 1), α-ketoglutaric (2), and oxalacetic hydrazones (1, 2, together), of 0·66, 0·44, 0·3 and 0·2 respectively.

Properties of the isomeric hydrazones. A detailed examination of the two pyruvic acid hydrazones (1 and 2, Table 1), extracted from a number of paper chromatograms, has shown that they are probably *cis-trans* geometrical isomers, around the C=N bond of the hydrazone. A similar conclusion has been reached independently for the 2 : 4 dinitrophenyl hydrazones of glyoxylic and α-ketobutyric acids by Dr. H. B. Stewart (in the press, *Biochem. J.*), who also suggests that the *cis* isomer is stabilized by a hydrogen bond between the imino and carboxyl groups. The absorption spectra of the two hydrazones of pyruvic acid in 0·2 *M* sodium bicarbonate are very similar to each other ($\lambda_{max.}$ 380 mμ and 370 mμ respectively; cf. 2 : 4 dinitrophenyl hydrazine of acetaldehyde[7] 360 mμ; $\varepsilon_{max.}$ the same within the accuracy of the measurements). The difference in $\lambda_{max.}$, 10 mμ, is very similar to that observed for isomeric oximes[8] and aromatic diazo cyanides[9]. Each hydrazone, subjected to the reaction conditions described above and then examined on the paper chromatogram, gave rise to a mixture of both hydrazones, the relative amounts of which varied with the length of the treatment and temperature, reaction at 70° for 5 min. giving the equilibrium mixture. It had been observed in the preliminary experiments that the ratio of the two hydrazones produced under the standard reaction treatment also varied with the original concentration of pyruvic acid, the ratio of hydrazone 2 to hydrazone 1 being about 2 : 1 at a concentration of 0·001 *M* and 3 : 1 at 0·004 *M*.

The two hydrazones had different absorption spectra in dilute sodium hydroxide. The red colour produced by dissolving the hydrazones in dilute alkali had been used by previous workers for the colorimetric estimation of these derivatives; but it was clear from an examination of the absorption spectra that not only variations in the strength of the alkali, especially above 1·5 *N*, affected the intensity of the red colour, but also that the two isomers had very different absorption spectra and only one gave any appreciable red colour.

A similar but less detailed examination was made of the two hydrazones of oxalacetic acid and α-ketoglutaric acid, and a similar conclusion that they were *cis-trans* isomers was reached. $\lambda_{max.}$ and $\varepsilon_{max.}$ were very similar to those for the pyruvic acid hydrazones. The mixture of oxalacetic acid hydrazones (1 and 2, Table 1) and the single hydrazone normally obtained from α-ketoglutaric acid had $\lambda_{max.}$ at 385 mμ.

Quantitative estimation of α-keto acids. The reaction conditions and chromatographic procedure have been described earlier. The hydrazones were eluted from the paper chromatograms with about 4 ml. of 0·2 *M* sodium bicarbonate and then diluted to 5 ml. with more 0·2 *M* sodium bicarbonate. Since the various isomeric hydrazones have a similar $\lambda_{max.}$ (370–385 mμ) and $\varepsilon_{max.}$, the estimation of the hydrazones extracted from the paper chromatograms was based on their extinction coefficient in 0·2 *M* sodium bicarbonate at a wave-length of 365 mμ or 404 mμ (mercury lines), whichever was more convenient. In all cases, for concentrations of hydrazone equivalent to 2–20 μgm. of α-keto acid, a linear relation was found between the concentration of hydrazone and the extinction coefficient. The amount of α-keto acid was calculated from the amount of hydrazone present; in the case of pyruvic acid, it was the sum of the contributions of the two individual hydrazones; but, in the case of oxalacetic acid, the hydrazones were extracted and estimated together. α-Ketoglutaric acid under the standard reaction conditions only gave one hydrazone.

When known quantities of α-keto acids (2–20 μgm.) were estimated quantitatively by the full procedure, the recovery was within ± 5 per cent.

The work described in this paper (so far as one of us (F. A. I.) is concerned) was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. We are indebted to Prof. G. E. Briggs, in whose department the work was carried out, and to the Agricultural Research Council for a grant to one of us (D. H. C.). [Aug. 22.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Symbols for Fundamental Particles

In recent years we have witnessed startling developments in the field of fundamental particles. One of the consequences has been the appearance in the scientific literature of a new jargon and of a large number of new symbols. Some symbols (such as π, μ, τ) designate specific kinds of particles. Others (such as ρ, σ) have been used to describe merely a phenomenological behaviour. Various authors have called the same particle by different names or have attached different meanings to the same symbol. Sometimes the meaning of a symbol has changed through the years. To give an example, the Greek letter $\varkappa$ was used initially to describe a heavy meson which stops in the emulsion and afterwards decays, giving rise to a single ionizing particle. Later, the Latin letter K replaced the Greek letter $\varkappa$ as a code for the above phenomenological description, while the letter $\varkappa$ acquired a more definite physical meaning: that of a heavy meson which decays into one charged and two neutral particles. Sometimes, however, the letter K is also used to designate any charged particle, heavier than a π-meson and lighter than a proton, the mode of decay of which is unknown. As another example, the neutral particle of mass about 1,000 m_e, which decays into two π-mesons, has been variously named v^0, V_2^0, V_4^0, whereas some authors have used the letter V_2^0 to designate any V^0-particle different from the so-called V_1^0.

It seems to us that, in order to avoid confusion, the time has come to agree upon a co-ordination of the symbols used to indicate fundamental particles or groups of fundamental particles. Our specific suggestions are listed in the table to follow.

We propose first to subdivide fundamental particles into three groups according to their mass and to denote each group by a Latin letter. We tentatively suggest the name 'hyperon' for a particle of mass intermediate between that of the neutron and the deuteron. We then suggest the use of Greek letters to indicate specific particles (as opposed to groups of particles). We note that this procedure has been widely followed in the past (recall the symbols γ, μ, ν, π, τ). We do not propose, however, to change the accepted symbols for the proton (p) or the neutron (n).

We finally suggest retaining and making more precise the phenomenological classification already in use, based on the empirical features of the decay process (V-particles, S-particles).

Classification of Particles

(*A*) Groups of Particles

Light mesons (L-mesons): π-mesons, μ-mesons, any other lighter meson which may be discovered.

Heavy mesons (K-mesons): all particles heavier than π-mesons and lighter than protons.

Hyperons (Y-particles): all particles with mass intermediate between that of the neutron and the deuteron (this definition might be revised if fundamental particles heavier than deuterons are discovered).

(*B*) "Christian Names"

Use capital Greek letters for hyperons and small Greek letters for mesons.

(1) *Hyperons*

Λ^0: particle previously known as V_1^0 and characterized by the decay scheme $\Lambda^0 \rightarrow p + \pi^-$. If it turns out (as suggested by some results) that there are particles with this decay scheme and different Q-values, they could be designated by different subscripts.

Λ^+: the positive counterpart of Λ^0 with the possible decay schemes: $\Lambda^+ \rightarrow n + \pi^+$; $\Lambda^+ \rightarrow p + \pi^0$.

The existence of these particles is indicated by recent experiments.

(2) *Heavy Mesons*

$\tau \rightarrow 3\pi$ (considered certain).

$\varkappa \rightarrow \mu$ + 2 neutral particles (considered very probable; however, the nature of the neutral products is still unknown).

$\chi \rightarrow \pi$ + 1 neutral particle (considered as probable; nature of neutral particle unknown).

θ^0: particle previously known as v^0, V_2^0, V_4^0, characterized by the decay scheme $\theta^0 \rightarrow \pi^\pm + (\pi^\mp$ or $\mu^\mp)$. If it turns out (as suggested by some results) that there are particles with this decay scheme and several Q-values, they could be designated by different subscripts.

(*C*) Phenomenological Categories

V-event: phenomenon which can be interpreted as the decay in flight of K-meson or Y-particle. Subdivisions: V^0-event, decay of a neutral particle; $V^\pm$-event, decay of a charged particle.

S-event: phenomenon which can be interpreted as the decay at rest of a charged K-particle or Y-particle.

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Ionic Distribution deduced from the *g*-Factor of a Ferrimagnetic Spinel: Ti^{4+} in Fourfold Co-ordination

The distribution of the metallic ions among tetrahedral (A) and octahedral (B) sites in oxides with spinel structure[1] often cannot be accurately determined by X-ray diffraction because of the small difference of the scattering powers of the ions present.

For ferrimagnetic spinels, the ionic distribution may in certain cases be found from the extrapolated saturation magnetization at 0° K., which is the difference[2] between the magnetizations of the A and B sublattices. When the ionic moments inside each of the two sublattices are parallel (see ref. 3), the saturation moment (n_B) expressed in Bohr magnetons per 'molecule' is given by the formula:

$$n_B = |(\Sigma x_i g_i S_i)_A - (\Sigma x_i g_i S_i)_B| . \qquad (1)$$

In this equation, x_i is the number of ions per 'molecule' of the i^{th} metal in either lattice site; g_i, the g-factor, is $2mc/e \times$ (magnetic moment)/(angular

momentum); and S_i is the total spin quantum number of the i^{th} metal ion.

When only two kinds of metal ions are present, their distribution may be calculated with the aid of this equation, provided the g-factors are known[4].

When, however, three kinds of metal ions are present, additional data or assumptions are needed to find the ionic distribution. As additional data the effective g-factor (g_{eff}), as obtained from microwave absorption measurements, may be used, provided the ionic g-factors differ sufficiently.

For a real ferromagnetic containing one type of atom, Kittel[5] found the relation:

$$g = \frac{2mc}{e} \frac{\Delta M_{spin} + \Delta M_{orbit}}{\Delta J_{spin}},$$

which, since the changes (Δ) in the magnetic moment M and the angular momentum J are proportional to their absolute magnitudes, gives

$$g = 2\frac{M_{spin} + M_{orbit}}{M_{spin}} = 2\frac{M_{total}}{M_{spin}}.$$

In ferrimagnetics with spinel structure a strong negative exchange coupling exists between the two sublattices. If this interaction is infinitely large, the moments of the two sublattices will be rigorously antiparallel even during the precession movement, and only the resultant moment occurs in the resonance condition, which then is that given by Kittel. Thus for this case:

$$g_{eff} = 2\frac{|(M_{total})_A - (M_{total})_B|}{|(M_{spin})_A - (M_{spin})_B|},$$

which at 0° K. for completely parallel alignment of the ionic spins inside each sublattice gives:

$$g_{eff} = 2\frac{\left|\sum_i (x_i g_i S_i)_A - \sum_i (x_i g_i S_i)_B\right|}{\left|\sum_i (x_i S_i)_A - \sum_i (x_i S_i)_B\right|}. \qquad (2)$$

We will assume that the AB exchange coupling is sufficiently strong for this formula to hold to a good approximation.

As an example we shall give the results for the spinel $Ni^{II}_{1\cdot5}Fe^{III}Ti^{IV}_{0\cdot5}O_4$, for which we found (from measurements down to 20° K.) $n_B = 1\cdot45$, and for which H. G. Beljers determined for a sphere ($\varphi = 0\cdot5$ mm.):

	$\lambda = 3\cdot18$ cm.	$\lambda = 1\cdot24$ cm.	
g_{eff}	2·70	2·71	293° K.
	2·85	—	83° K.
g_{eff} (extrapol.)	2·90		0° K.

The general formula for the ionic distribution is

$$[Fe_{1-x-y}Ni_yTi_x]_A \quad [Ni_{1\cdot5-y}Fe_{x+y}Ti_{0\cdot5-x}]_B \; O_4;$$

for which, assuming generally $g_{Ni^{2+}} = 2\cdot3$,

$$n_B = |5(1-x-y) + 2\cdot3y - 2\cdot3(1\cdot5-y) - 5(x+y)| = 1\cdot45,$$

and

$$g_{eff} = \left|\frac{n_B}{\frac{5}{2}(1-x-y)+y \quad -(1\cdot5-y) - \frac{5}{2}(x+y)}\right| = 2\cdot90.$$

This gives $x = 0\cdot30$, $y = 0$, that is, the ionic distribution:

$$[Fe_{0\cdot70}Ti_{0\cdot30}]_A \; [Ni_{1\cdot50}Fe_{0\cdot30}Ti_{0\cdot20}]_B \; O_4.$$

(J. S. Smart, who has independently applied the same method for the determination of the ionic distribution in the system $NiFe_2O_4-NiAl_2O_4$ (recent private communication), uses $(g_{Ni^{2+}})_B = 2\cdot3$; but $(g_{Ni^{2+}})_A = 3\cdot5$. This would, in our case, give the same values of x and y.)

The assumption used, namely, that the ionic moments inside each sublattice are parallel, is plausible for this material in view of the high Curie temperature ($\sim 565°$ K.), and can be proved by a molecular-field treatment[6], using the Curie temperature and saturation data of the system $NiFe_2O_4 - Ni_{1\cdot5}FeTi_{0\cdot5}O_4$[7].

The presence of Ti^{4+} ions in tetrahedral sites is rather unexpected. To our knowledge the only indication of Ti^{4+} in fourfold co-ordination so far obtained is the incorporation of Ti^{4+} activator ions in SiO_2 and Zn_2SiO_4 phosphors[8]. It is interesting to note that the first indication that a proportion of the Ti^{4+} ions occupy tetrahedral sites has been obtained by Niessen[9] by a molecular field treatment, using the Curie temperature data[7].

I am much indebted to my colleagues J. Smit, for discussions on g-factors, and H. G. Beljers, for the measurements.

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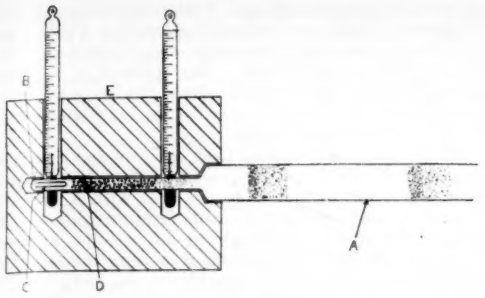
Distillation and Determination of Boiling Points on a Microscale

Distillations and fractionations of milligram quantities of liquids have been carried out successfully by Gettler and Fine[1] and Morton and Mahoney[2], using somewhat complicated adaptations of the Emich-type tube[3]. Also using Emich's method, but extending it to work at different pressures, Garcia[4] determined the boiling points of 2–3 mm.[3] quantities.

The simple apparatus described here permits the quick and accurate determination of boiling points with quantities of material of 1–3 mgm. and, with certain limitations, the fractional distillation on a microscale, using a glass tube the inner surface of which has been ground opaque. This opaque surface becomes transparent when moistened by a condensate, so that it is possible to establish: (1) when condensation takes place; (2) where condensation takes place; (3) the quantity of condensate (from the size of the transparent spot).

The apparatus (Fig. 1) consists of a 3-mm. bore tube A the inside of which has been ground to opaqueness. The length of A depends upon the purpose for which it is to be used; for determinations of boiling points, a length of 10 cm. is sufficient, whereas for fractionations lengths of 30 or 40 cm. are required. Tube A is connected with a narrower tube B (1 mm. bore, 8 cm. length), the far end of which is sealed off. A capillary C with the liquid sample is introduced into the narrow end of the tube B, the remainder of which is then filled with ground glass, D. The whole of B and about 1 cm. of tube A are inserted into a



heating block *E* with two thermometers placed very near the two ends of *B*.

The block is heated with a gas burner or electrically in such a manner that both thermometers show the same temperature. When the temperature, which is raised at a rate of 4–6 deg. C. per min., approaches the boiling point of the sample, a flash of moisture appears in tube *A* at a distance of about 2–3 cm. from the heating block. At the actual boiling point, part of tube *A* near the block becomes transparent, the transparent zone developing first from the initial flash towards the heating block, then spreading away from it. Even without much practice, it is easily possible to determine boiling points with an accuracy of 1–2 deg. C. The apparatus is readily adaptable to determinations of boiling points at pressures other than atmospheric.

Results obtained with a number of substances are summarized in Tables 1 and 2.

Table 1. Determination of Boiling Points at Pressures of 693 mm. Mercury

Material	Boiling point (° C.), found	Boiling point (° C.), literature*
Water	98	98
Methyl alcohol	63	63
Ethyl alcohol	76	76
n-Propyl alcohol	94–95	95
*iso*Butyl alcohol	104	104
Acetone	52–53	53
Aniline	180–181	181
Nitrobenzene	203–206	205

*From the International Critical Tables.

Table 2. Determination of Boiling Points at Pressures of 22–23 mm. Mercury

Material	Boiling point (° C.), found	Boiling point (° C.), literature*
Acetophenone	94–95	94·5
Benzonitrile	85	85
Nitrobenzene	100	99
Ethyl phenylacetate	118–120	116–118 (18 mm.)

*From the International Critical Tables.

The quantity of the distillate can be determined from the length of the transparent spots formed during distillation. In this case, standardization of the spots is necessary, plotting the length of the spot appearing in a given time against the quantity of material. Examples for such quantitative determinations are given in Table 3.

This method makes it possible to carry out the fractionation of liquid mixtures on a microscale. In this case, each fraction condensed near the block is driven over, by cautious heating, to a more distant part of tube *A*. Moist filter paper is applied at this part to enhance condensation.

Table 3. Quantitative Determination of Distillates

Material	Weighed (mgm.)	Found (mgm.)
Benzene	0·80	0·90
"	1·10	1·00
"	1·90	1·70
"	2·25	2·45
"	2·50	2·40
"	2·90	3·10
Toluene	0·95	1·10
"	1·10	1·20
"	1·40	1·20
"	2·10	2·20
"	2·15	1·90
"	2·20	2·45
"	3·05	3·20
"	3·75	3·90
Xylene	0·95	1·00
"	1·70	1·90
"	1·90	1·70
"	2·10	2·20
"	2·30	2·15

A detailed description of the method will be published elsewhere. This investigation has been carried out under the auspices of the Scientific Department, Israeli Ministry of Defence, and is published with its permission.

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New and Known Complex Borohydrides and some of their Applications in Organic Syntheses

We have found that alcoholic solutions of lithium borohydride can be obtained by a new and very simple method: solutions of sodium borohydride and lithium chloride in absolute ethanol give, on mixing at − 10° C.—in metathetical reaction—a nearly pure solution of lithium borohydride:

$$NaBH_4 + LiCl = LiBH_4 + NaCl.$$

85–90 per cent of the calculated amount of sodium chloride can be filtered off; thus we obtain a solution which contains 85–90 per cent of the theoretical amount of lithium borohydride and 10–15 per cent of sodium borohydride. We have investigated the stability of these solutions; very surprisingly, these alcoholic solutions of lithium borohydride showed no appreciable decomposition in 2–4 hr., provided that the temperature remained at about 0°. This observation is in sharp contrast with the results of others[1], according to which this substance decomposes with alcohols very rapidly, evolving hydrogen. (Schlesinger, Brown and Hyde have recently described[2] the preparation of lithium borohydride by the reaction of lithium chloride and sodium borohydride in *iso*-propylamine; for preparation in quantity their method is better than ours.)

We have used these solutions for the reduction of several ketones. For example, 3β-hydroxy-17-keto-Δ^5-androsten (dehydroandrosterone) gives on reduction with such a solution 3β-17β-dihydroxy-Δ^5-androsten with a nearly theoretical yield. Only a few per cent of the corresponding 3β-17α-diol was formed as a by-product.

By a similar method but at lower temperatures (between − 50° C. and − 20° C.) we have been able to prepare alcoholic solutions of other borohydrides. From calcium chloride and sodium borohydride we have obtained an alcoholic solution of the hitherto unknown calcium borohydride:

$$2\ NaBH_4 + CaCl_2 = Ca(BH_4)_2 + 2\ NaCl.$$

Using magnesium chloride, we have obtained a solution of magnesium borohydride. This compound was previously prepared in a very complicated manner by the reaction of magnesium diethyl and diborane[3]. These solutions are of lower purity than the solutions of lithium borohydride and contain about 80 per cent of calcium or magnesium borohydride and about 20 per cent of unreacted sodium borohydride. Calcium and magnesium borohydrides cannot be prepared by the *iso*propylamine method. The use of very dry ethanol is essential, because these borohydrides are much more sensitive to water than lithium borohydride. The reducing properties of these alkaline-earth borohydrides have been found to be very similar to those of the alkali borohydrides. Aldehydes and ketones are reducible to the corresponding carbinols; naturally, to avoid the too rapid alcoholytic decomposition of the borohydrides, it is necessary to work at low temperatures (about − 5° C.). Dehydroandrosterone could be reduced to the androsten with calcium or magnesium borohydride, in very good yield. Only a few per cent of the corresponding diol was formed; but reduction with sodium borohydride gave a much larger quantity.

The selectivity of the reducing properties of calcium and magnesium borohydrides resembles the selectivity of sodium borohydride. Nitro groups, double bonds and carboxyl groups remain unchanged. Their solutions are nearly neutral, in contrast to the solutions of alkali metal borohydrides, which are strongly alkaline. This can be advantageous in the reduction of alkali-sensitive compounds; for example, in the reduction of sugar derivatives. Here their peculiarity that their cations are separable in a simple manner from water solutions can be of further advantage.

We have further investigated the reduction of esters to primary carbinols with alcoholic solutions of lithium borohydride. Ethyl *p*-nitrobenzoate was reducible to *p*-nitrobenzyl alcohol but the yield was poor. (Obviously, at the higher temperature necessary for reduction of the ester group, the concurrent alcoholytic decomposition of lithium borohydride becomes more important.) After some experimentation, we have found it is more satisfactory to stir a solution of an ester in tetrahydrofurane with sodium borohydride and lithium iodide, when a smooth reduction takes place and the carbinol is formed in very good yields; for example, ethyl *p*-nitrobenzoate gave an 80 per cent yield of *p*-nitrobenzyl alcohol. A plausible explanation for these reactions is as follows: sodium borohydride and lithium iodide first give a very small amount of lithium borohydride; this then reacts at once with the ester with formation of the carbinol. In this manner the equilibrium:

$$NaBH_4 + LiI \rightleftarrows LiBH_4 + NaI$$

will be pushed to the right, and eventually the full quantity of sodium borohydride will be transformed to lithium borohydride. This mechanism is supported by the fact that sodium borohydride gives no detectable amount of lithium borohydride on stirring in tetrahydrofurane. Only the presence of an ester causes complete metathesis. With catalytic quantities of lithium iodide we obtained a smaller yield. No reduction takes place on substituting lithium chloride or bromide for the iodide. Our method is the first application of sodium borohydride (which is the only borohydride produced to-day on an industrial scale) to the reduction of esters.

Since our work was carried out, we have seen a paper by R. Paul and N. Joseph[4]. They have found that esters are reducible to alcohols with a mixture of potassium borohydride and lithium chloride in tetrahydrofurane. Contrary to our results, in their experiments the combination of sodium borohydride and lithium salts was incapable of the reduction of esters. We cannot for the present explain their negative results.

Our investigations are being pursued, particularly in their stereochemical aspects. Detailed accounts of the work will be published in the *Acta Chimica Hungarica*.

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Synthesis of Fluoropyruvic Acid and some of its Biological Properties

The theory suggested by Martius[1] and Liebecq and Peters[2] for the mode of action of fluoroacetic acid assumes that fluoroacetic acid substitutes itself for its parent substance and 'misuses' the enzymatic apparatus normally acting on acetic acid for a 'lethal' synthesis of the poisonous fluorocitric acid[3]. While the enzymatic formation of fluorocitrate from fluoroacetic acid seems to be sufficiently established by the extensive work of Peters and his co-workers[4], there is as yet no experimental proof that this synthesis is mediated by the same mechanism and the same enzymatic system as that by which acetate undergoes condensation with oxaloacetate to citrate. In fact, some recent results of Peters[5] seem to point to the contrary and to suggest that fluoroacetate is not acted upon by the system capable of activating acetic acid.

As pyruvic acid constitutes an energetically self-propelled generator of 'active acetyl' (acetyl-coenzyme *A*) and therefore a more ready donor of active acetyl than acetic acid, it seemed interesting to synthesize fluoropyruvic acid and to study its biological and pharmacological properties. To quote a statement by Chenoweth[6]: "one searches in vain the literature for mention of the existence of fluoropyruvic acid F—CH_2—CO—COOH, which might be utilised to settle some of these questions".

In order to prepare fluoropyruvic acid, diethyl sodio-oxalofluoroacetate[7] was subjected to simultaneous saponification and decarboxylation, by heating the compound with dilute hydrochloric acid for 6 hr. From the concentrated solution, the acid was extracted with ether. It boiled at 98°/5 mm. and solidified to a cream-white, crystalline mass, very soluble in water, insoluble in hydrocarbons; its odour resembles that of pyruvic acid (calc. for

$C_3H_3O_3F$: C, 34·0; H, 2·8 per cent; found: C, 34·0; H, 3·1 per cent). It gives readily a dinitrophenylhydrazone, melting point 127°, and a semicarbazone (from *n*-butanol) of melting point 205° (dec.) (calc. for $C_4H_6O_3N_3F$: C, 29·6; H, 3·7; N, 25·7 per cent; found: C, 30·0; H, 3·8; N, 25·3 per cent). Both derivatives showed the expected infra-red spectra; the C—F absorption band lies at 980 cm.$^{-1}$.

When fluoropyruvic acid was treated with a solution of ceric sulphate in sulphuric acid in the Warburg apparatus, nearly the theoretical amount of carbon dioxide was liberated. The acid was also attacked, though slowly, by yeast carboxylase, with liberation of carbon dioxide.

The *LD*50 for both mice and rats was *c.* 80 mgm./kgm., that is, about ten to twenty times less than the corresponding *LD*50 for sodium fluoroacetate. No convulsive symptoms, which are so characteristic of fluoroacetate poisoning, were observed, and only a slight increase of the citric acid content in the organs of the poisoned animals was found.

In contrast to this relatively low toxicity for animals, fluoropyruvic acid shows a rather strong inhibitory effect on the growth of *Escherichia coli* and *Aerobacter aerogenes* in a synthetic medium containing ammonium salts as the sole source of nitrogen. A quantity of 20 μgm./ml. completely suppressed growth of the two bacteria for 24–36 hr.

Additional proof of the structure of fluoropyruvic acid was obtained in the following way. The substance was subjected to oxidative decarboxylation with hydrogen peroxide[8] and the solution obtained tested for toxicity. It showed, indeed, the toxicity (to mice) which would be expected for the corresponding quantity of fluoroacetic acid, and high levels of citric acid could be demonstrated in the organs of the poisoned mice.

The study of the mode of action of fluoropyruvic acid is being continued.

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Separation of Volatile Acids by Paper Chromatography

A method for the identification of volatile fatty acids by means of paper chromatography was reported by Hiscox and Berridge[1]. In this method the acid was applied as the ethylamine salt to the paper, and the chromatogram was run with water as the stationary phase and butanol as the mobile phase in an atmosphere containing ethylamine vapour. In this system the fatty acids exist as anions. On spraying the developed chromatogram with a solution of bromcresol green in ethanol, a blue spot develops where the acid anion resides on the paper.

Difficulty in the location of the acid has been experienced on a number of occasions using low concentrations of acid, due to the colour often developed in the background. If the paper is sprayed on removal from the chromatography tank without adequate volatilization of the excess base, the deep blue of the background renders all observation useless, and, on ageing, the whole field may present a mottled green appearance. If the paper is blown dry for too long a period, it is sometimes impossible to assess the acid position.

The following technique has been found useful in locating the position of the acid spots. After running, the paper is suspended in a fast stream of air drawn in by lowering the front of a fume cupboard to within a few inches of the base, and a mist spray of ½ per cent solution of bromcresol green in ethanol is applied at short intervals, just behind the receding solvent front. The background still shows a faint blue, but wherever the acid anion resides an ovoid deep blue 'blush' appears, and this is immediately pencil-marked. Further changes in the background colours are then of no consequence, as a permanent record is obtained.

This technique, applied to the original method, has given satisfactory results over quite wide ranges of ethylamine vapour concentrations.

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Occurrence of Indole-3-Acetic Acid in Laminæ of *Hevea brasiliensis*

It became necessary during the examination of the effect of various mineral nutrients on rubber production in *Hevea* to investigate the occurrence of indole-3-acetic acid in the laminæ. Although it is assumed that this auxin is present in most plants, this assumption has never been verified for *Hevea*. Chapman[1] showed by means of the *Avena* curvature test that in some instances the yield of rubber was related to the concentration of 'hormones' in the latex serum but did not indicate specifically that indole-3-acetic acid was present.

Numerous attempts were made in this laboratory to estimate the auxin content of laminæ using the extraction and colorimetric-estimation methods described by Henderson and Bonner[2]. Despite the careful fractionation of the acid and neutral fractions of the ether extracts prepared from such large quantities as 500 gm. of young laminæ, the methods were unsuccessful even after such diverse treatments as freezing, autoclaving, acid and alkaline hydrolysis or enzymatic digestion. It appeared that the quantity of auxin present was either too small for successful estimation, or that interfering substances were present which prevented the development of the pink colour. Comparatively small proportions of indole-3-acetic acid were recovered after the addition of known amounts to the leaf plus ether breis; this destruction or possible 'masking' of the auxin was not prevented by the addition of compounds known to inhibit[3] the inactivation of auxin by various oxidizing agents and enzymes. However, using the chromatographic bioassay method devised by Luckwill[4] and Bennet-

Clark, Tambiah and Kefford[5], it was possible to prove the presence of indole-3-acetic acid in leaf extracts.

25–50 gm. of young recently expanded laminæ were extracted at 6–9° C. with peroxide-free ethyl ether for periods varying from two to thirty days. The extracts were filtered and evaporated under reduced pressure without the application of heat. The concentrated extracts were chromatographed using the descending method and the solvents described by Bennet-Clark *et al.*[5]; the paper strips were then cut into segments 3 cm. square, to each of which 5 ml. of 3 per cent sucrose solution was added. Elution was allowed to take place for 20 hr., after which time five or ten sections (each 5 mm. long) of oat coleoptile (Aberystwyth *S.*221) were added to each eluate and incubated at 24–26° C. for 17 hr. The percentage elongation of each section over its original length was calculated; a representative illustration of the type of result obtained is given in Fig. 1. The ordinates represent the difference between the percentage elongation of the sections grown in solutions prepared from papers 'spotted' with either known amounts of auxin or concentrated leaf extracts and the elongation obtained from sections grown in a solution prepared from papers 'spotted' with water only and then chromatographed in the usual manner, that is, the 'blank' or 'control' sections. The abscissæ represent the distance of the segments from the starting line.

At a distance of 12–24 cm. from the starting line, definite growth stimulation occurred (Fig. 1*A*); this region was identical with that of guide strips which when sprayed with the ferric chloride – perchloric acid reagent gave a definite pink area—thus indicating the presence of indole-3-acetic acid. This region of growth stimulation, which had an R_F value of approximately 0·3–0·5, was given by all extracts examined. On this evidence, therefore, and the fact that growth activity could always be induced by this region when synthetic indole-3-acetic acid was added to the paper (Fig. 1*C*), the activity obtained when leaf extracts were used must be attributed to the presence of this auxin.

It was noticeable that although the addition of as much as 50 μgm. of indole-3-acetic acid to laminæ plus ether, during the process of extraction, produced a larger area of growth activity than did the direct application of 5 μgm. of the auxin (Figs. 1*B* and 1*C*), the relative difference was smaller than expected. This was not thought to be due to a toxicity effect (as the original 50 μgm., if fully recovered, would be contained in 25 ml. of eluate, that is, five segments), but was attributed to the presence of a system in the leaves which slowly inactivated the added indole-3-acetic acid.

There was no consistent indication of any other growth activity in any other part of the chromatogram; this possibility, however, is being further investigated.

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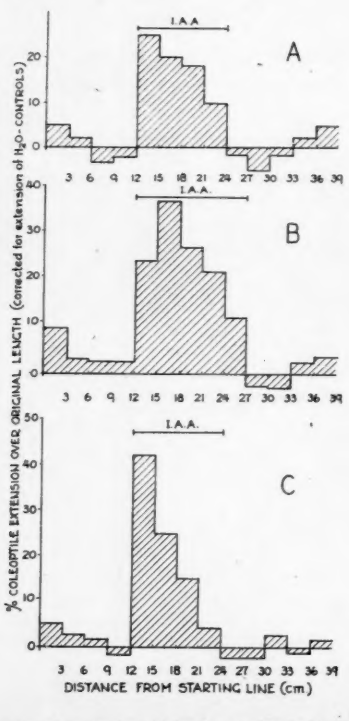
I.A.A.
A
B
C
% COLEOPTILE EXTENSION OVER ORIGINAL LENGTH (Corrected for extension of H_2O - CONTROLS)
3 6 9 12 15 18 21 24 27 30 33 36 39
DISTANCE FROM STARTING LINE (cm)

Fig. 1. Coleoptile extension obtained on application to paper of: (*A*) ether extract of 50 gm. *Hevea* laminæ; (*B*) ether extract of 50 gm. *Hevea* laminæ + 50 μgm. of indole-3-acetic acid; (*C*) 5 μgm. indole-3-acetic acid

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Respiratory Tissue of the Large Whales

Samples of lungs of blue- and fin-whales, provided by the kind co-operation of the "United Whalers", made it possible to study closely the structure of the respiratory tissue. The methods employed were serial sections and various kinds of staining.

Contrary to casual descriptions as recorded in the literature, the respiratory tissue has proved to differ fundamentally from that of terrestrial mammals. The customary nomenclature (as used, for example, by Wislocki and Belanger[1]) for the acinar structure of terrestrial mammals[2] is therefore barely applicable in describing the respiratory tissue of whales.

The respiratory tissue arising from the ends of the air passages represents a tuft of wide, long and much subdivided air saccules. The length is approximately 5–8 mm., whereas the air saccules even in the largest terrestrial mammals barely exceed 1 mm. and often are considerably shorter. This statement is based on a comparative study of terrestrial mammals of various sizes, from the mouse to the elephant (to be published in the near future).

In the large whales the saccules are pouches rather than slightly conical tubes. Large evaginations originate from the walls, their mouths being stiffened by a thick elastic ring (it is mainly elastic tissue and not myo-elastic tissue[1], as the elastic fibres are abundant and muscle fibres scarce). These evagina-

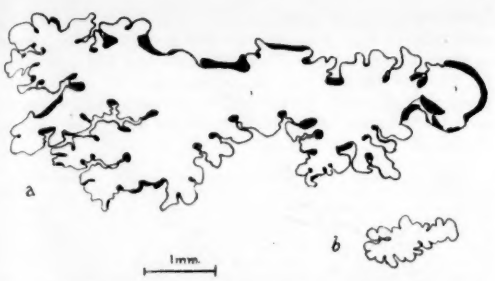

Fig. 1. Air saccules of (*a*) blue whale and (*b*) of elephant. The black areas are elastico-myal tissue

tions are not alveoli in the recognized sense of the word. They are lined with an abundance of capillaries and thus enlarge the respiratory surface. This capillary layer rests on fairly thick interstitial tissue, consisting of rather loose connective tissue, reinforced by strands of elastica (Fig. 1).

The wide pouches which, together with their evaginations, are so conspicuous, look much more primitive than the air saccules in the terrestrial animals; they rather resemble a miniature of the amphibian lung, the wall of which is also fitted with projections towards the lumen which produce cubicles similar to the niches of the lung of the whale.

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Short-lived Red Cells in Normal Individuals

NORMAL survival of red cells is reflected in the curves of nitrogen-15 tagging of hæm versus time. Such curves[1,2] have been analysed[1,3], but re-examination indicates that they might fail to reveal the presence of moderate fractions of very short-lived erythrocytes in normal individuals. Berlin *et al.*[4] observed an extra peak on the ascending portion of the nitrogen-15 hæm curve in a case of polycythæmia vera. This clearly reflects the presence of short-lived erythrocytes. The present communication describes evidence for the occurrence of short-lived erythrocytes in normal individuals. This evidence is of two independent types.

First, assume that nitrogen-15-tagged fæcal stercobilin originates only in the tagged circulating hæm and then find what erythrocyte survival is reflected in the experimental curves of tagged stercobilin. Let $\varphi = \varphi(\tau)$ be the fraction of erythrocytes surviving τ days, let b represent the fraction of remaining hæm nitrogen-15 excess which is released daily from the marrow, and let $z = z(t)$ be the stercobilin output on the t^{th} day. Then if A is the total amount of tagging:

$$z = -\int_0^t bA \exp\{-b(t-\tau)\}\left(\frac{d\varphi}{d\tau}\right)d\tau;$$

by differentiation and substitution:

$$\frac{dz}{dt} = -bz - bA\frac{d\varphi(t)}{dt};$$ and finally, by integration:

$$\varphi(\tau) = 1 - z(\tau)/bA - \int_0^\tau z(s)ds/A. \qquad (1)$$

The integration in equation (1) can be done graphically or otherwise in determining survival φ from stercobilin z. The value of b is taken from the rate of rise on the tagged hæm curve. The dotted curve of Fig. 1 is a simplified expression (with interpolation and extrapolation) of the data of London *et al.*[5]. It yields (by equation (1), $b = 0{\cdot}12$, and the fact that $A = \int_0^\infty z(s)ds$) survival values φ which are represented by the smoothed-out solid curve of Fig. 1. This curve reveals that about an eighth of this individual's erythrocytes are very short-lived and that another quarter of them have varying and only moderate survivals. The average survival here is not quite 90 days.

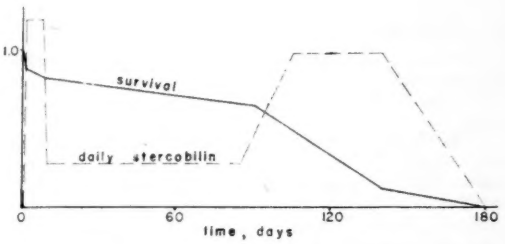

Fig. 1. Erythrocyte survival and tagged stercobilin output in a normal male

For the second type of evidence, let V be blood volume in c.c., h be hæmatocrit in c.c./c.c., M be amount of erythroid bone marrow in c.c., $1/b$ be the average marrow erythrocyte production time in days, and Λ be the average erythrocyte survival in days. Then:

$$\text{Daily loss} = hV/\Lambda = \text{daily production} = bM, \qquad (2)$$

$$\text{or} \quad \Lambda = hV/bM. \qquad (3)$$

In the average normal adult male $h = 0{\cdot}45$ and $V = 5{,}000$ approximately. The data of Wintrobe[6] show that M is at least 200. These values and the previous value $b = 0{\cdot}12$ cause equation (3) to yield $\Lambda = 94$ days. Comparison of this result with previous estimates of about 120-day survival (even for the same individual[2,3]) gives striking evidence that normal erythrocyte populations include short- and moderate-lived members.

The results of C. A. Finch *et al.*[7] imply that b is normally about $0{\cdot}17$, and this value would give, from equation (3), values near 70 days, which would imply even more short-lived erythrocytes.

Another use of equation (2) is the calculation of the amount of erythroid marrow hyperplasia in cases of hæmolytic anæmia, whenever the values of V, h, b and Λ can be determined independently. Examples of this use will be reported separately.

I wish to thank my colleagues, Drs. D. S. Amatuzio, R. J. Goldish, P. S. Hagen and C. J. Watson, for many helpful, varied and separate discussions on this subject.

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Architomy in a Species of *Convoluta*

On the south-eastern coasts of southern Africa, there occurs a species of *Convoluta* which shows the rare phenomenon of asexual reproduction by architomy or scissiparity.

Specimens of this species have been collected by one of us (W. M.) from various localities between Cape Padrone and Inyack Island, at the entrance to Delagoa Bay. The worm was first noticed by Warren[1], whose identification with the well-known *Convoluta roscoffensis* was accepted without comment by von Graff[2]. Wager[3] described rather more fully some of the peculiarities and habits of the worm. He mentions several points of difference from the European species and directs attention to the fact that he could find "no signs of any sexual organs either in the living animal or in microtome sections". In serial sections prepared by one of us (E. M.), of twelve specimens with recognizable germ cells, no trace could be found of the "kurzen, glockenförmigen Penis" which von Graff[4] described for *C. roscoffensis*. Several living specimens have been examined by W. M. in an attempt to find rudimentary traces, but none was found although moving sperm were seen in the vas deferens. Westblad[5] has described a species of *Convoluta* without any form of male organ apart from a fine canal, and it would appear that the South African specimens belong to such a species and so are different from *C. roscoffensis* and certainly constitute a new species of which a description will be published elsewhere. Also, as Warren[1] has already observed, the mouth lies farther forward than it does in the European species and much nearer to the statocyst than this organ is to the tip.

Populations on open ocean beaches usually contain very long individuals assorted with short ones, which have young heads (without frontal organs) and tails. The long individuals may show lines of constriction at various levels which are paler than the rest of the body. One specimen was seen to divide, and the portions which separate off, though lacking head and tail, were quite capable of moving around, apparently in a normal manner. It appeared merely to break into two without reference to the lines of constriction mentioned. Wager[3] has already described this phenomenon, but his observations seem to have been overlooked by all later workers and have not passed into any of the treatises on the group. His paper is mentioned in the *Zoological Record* (**50**, Vermes, p. 21, No. 439), but the contents are summarily given as "habits". In view of the considerable interest and importance of his observations they are quoted in full:

> "The reproduction is the most peculiar feature of the animal. After repeated observations I could find no signs of any sexual organs either in the living animal or in microtome sections. Whether sexual reproduction has been discarded altogether, it is, of course, difficult to say, but in any case there is a prolific means of asexual reproduction which, I believe, has not previously been reported, that is, by the severance of parts of the animal, each part being able to form itself into a new animal. This severance may be due to accident, such as being dashed against the sand, stones, etc., in which case the delicate animal comes off badly, but even the smallest pieces appear able to regenerate. I have divided a single animal into four parts, and after about two hours each part had assumed the elongate ribbon shape of the mature animal, swimming about the whole time. This method of reproduction by the regeneration of parts is of course well known in many animals such as *Hydra*, but it is only resorted to in case of accident. The animals concerned cannot be said to reproduce by this method. In the case of *Convoluta*, however, the delicate nature of the animal is one of its peculiar features, the slightest touch causing it to break or become damaged. In many cases the animal actually puts out protuberances which gradually elongate, and then become separate. This process takes only a short time—about an hour to complete, so that this is hardly a case of budding in so far as the protrusions are not formed by growth."

This phenomenon of architomy is common among *Tricladida paludicola*. *Catenulida* and *Microstomida* divide paratomically. The method is unrecorded for *Acoela*, though Dr. Erich Shultz of Kiel has independently re-discovered the phenomenon in some *Acoela* from the Baltic. He has frequently mentioned his observations in letters to one of us (E. M.), but has not yet published them.

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Contact Chemoreceptors of Blowfly Tarsi

The contact chemoreceptors of blowfly tarsi have been the subject of much experimental work since the existence of a tarsal taste sense in the Calliphoridae was discovered by Minnich[1]; the literature has been reviewed elsewhere[2,3]. The receptors concerned have not been positively identified and no details of the structure of the receptor surface have been reported.

The tarsal contact chemoreceptors of *Protophormia terraenovae* R.-D. are located in two ventral rows on each tarsal segment, adjacent to two rows of stout spines which protect the thin-walled receptors from mechanical damage. There are approximately 260 chemoreceptors on each fore-tarsus, and 150 on each middle- and hind-tarsus, in both sexes. The receptors are 40–60 μ long except at the distal extremity of each segment, where receptors 150 μ and 240 μ long are located.

Each chemoreceptor is a flexible, hollow seta characteristically innervated by a spindle-shaped

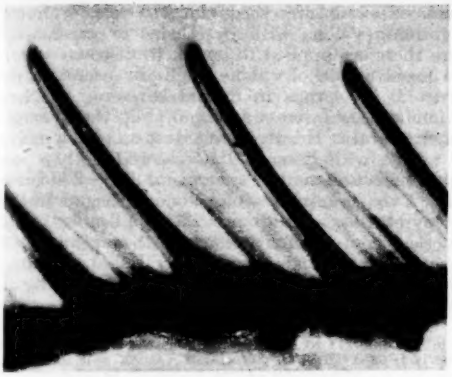

Fig. 1. Longitudinal section of tarsal chemoreceptors, *P. terraenovae* R.-D., showing frontal membrane (unstained). × 1,050

group of six to eight sensory cells. The cuticle of each receptor is differentiated longitudinally into an exceedingly delicate frontal membrane and a thicker, opaque posterior wall (Fig. 1). The frontal membrane extends the full length of the receptor and represents about one-quarter of the total receptor surface. It is best seen in section or when tarsi are mounted in polyvinyl lactophenol, in which medium the receptors curl back, displaying the membrane clearly.

Evidence that the setæ are chemoreceptive has been obtained in experiments with starved flies. When a row of setæ of the above type was touched with a fine hair moistened with 10 per cent sucrose solution, the proboscis of the stimulated fly was extended. No response was obtained with a clean dry hair, and no response to sucrose could be obtained elsewhere on the tarsi. Stimulation of single receptors failed to produce a response; stimulation of several receptors appears to be necessary to excite starved flies to a positive feeding response.

There is little doubt that the frontal membrane, a fraction of a micron thick, is the boundary across which molecules stimulating a chemoreceptor diffuse. The elucidation of its structure and constitution would therefore be of considerable interest.

Preliminary experiments indicate that the cement layer of the normal integument is continued over the frontal membrane, and that a waxy barrier hinders the passage of water across the membrane. These conclusions are based on observations of the contact angles of fine drops of distilled water precipitated on chilled tarsi in the form of dew, and on the action of oils and mixtures of oil and alcohol on the receptors.

Thus, in spite of the fact that the chemoreceptors respond to aqueous solutions of a wide variety of substances, a continuous lipoid epicuticle appears to be present. This affects the interpretation of data concerning the stimulation of receptors. It has been observed[2] that the rejection thresholds of aqueous solutions of organic substances and of inorganic electrolytes appear to be inversely related to lipid solubility or to oil–water distribution coefficients. It should be pointed out that two processes are involved in the chemical stimulation of an end organ: (*a*) the penetration of the receptor wall; (*b*) the irritation of the sense cells by the molecules which penetrate. Differences in threshold concentrations of distasteful substances may be a measure of their ability to penetrate a lipoid barrier in the receptor membrane rather than a measure of differences in the sensitivity of the sense cells to the substances.

Ventral rows of setæ similar in structure to those described above occur on the tarsi of *Phormia regina* M., *Lucilia sericata* M. and *Lucilia illustris* M. They are probably homologous to the hollow thin-walled setæ possessing an eccentrically placed chitinous partition which Tinbergen[4] reported to be distributed in the gustatory regions of *Calliphora erythrocephala* M.

These observations were made during an investigation into the mode of action of contact insecticides, financed by the Colonial Office. A full account of the work will be published elsewhere.

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Tick Paralysis in the Dog

In all areas from which human cases of tick paralysis have been reported, the disease appears to occur, at least occasionally, in dogs. In any attempt to solve what Gregson[1] has called the enigma of tick paralysis, it is essential to be able to reproduce consistently the condition experimentally; this has hitherto proved impossible when the acarid *Dermacentor andersoni* Stiles has been used.

In preliminary work we have produced paralysis on seven occasions in long-haired mongrel dogs with *D. andersoni* collected near Kamloops, British Columbia, by Mr. J. D. Gregson. The ticks were sent to Ottawa by air express and kept in the refrigerator until used. In all experiments both males and females were applied to the animal. In no instance when the females became attached did they fail to produce paralysis. Details of the experiments are as follows:

Dog No.	1	2	2	3	4	4	4
No. of female ticks feeding	9	1	4	8	1	3	5
No. of days until onset of paralysis	6	8	4	7	15	4	2

Except in one case, the ticks were removed when the animal was completely paralysed but before the respiratory muscles had become affected. In the first experiment on dog No. 2, paralysis was limited to the fore limbs and recovery was spontaneous although the tick continued to feed and completed its engorgement.

These results furnish additional evidence that the disease due to *D. andersoni*, the commonest cause of tick paralysis in North America, differs from that occurring in Australia, where *Ixodes holocyclus* (Neumann) is involved. In the latter disease an immunity may be built up in the dog[2], whereas in our series there is no evidence that immunity occurs, and dog No. 4 showed an increasing susceptibility with each infestation. Vomition, which is described as a characteristic feature of Australian tick paralysis[3], did not occur in our dogs.

When dog No. 4 was moribund with tick paralysis for the third time it was bled, and the 250 ml. of blood obtained was given intravenously to another

dog in an effort to detect any circulating toxin. The transfused dog showed no evidence of paralysis.

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Insecticidal Synergism with Valone

The insecticidal properties of valone (2-*iso*valeryl 1,3-indandione) were being investigated some years ago[1], when the material was apparently eclipsed by the discovery of DDT. Recent tests on insect pests of stored products have shown that, although not outstandingly insecticidal by modern standards, valone has an unusual combination of properties; namely, (1) if the dose is high enough to be lethal, it kills the insects rapidly, (2) in sub-lethal doses it produces a paralysis from which insects afterwards recover, and (3) the percentage mortality is unusually sensitive to changes in dose. (2) indicated that insects can detoxify valone. By analogy with the probable mode of action of synergists for pyrethrins[2] and DDT[3], that is, depression of the normal detoxification of the insecticide, it seemed possible that the insecticidal action of valone could be intensified by a suitable synergist. Furthermore, (3) suggested that the synergist need not be highly efficient in order to increase the mortality considerably.

A number of compounds were therefore tested in the laboratory for synergism with valone, using the flour beetle, *Tribolium castaneum* Herbst, as the test species. Most, including pyrethrin synergists, did not synergize valone appreciably, but certain insecticides did so, especially pyrethrins and gamma-BHC (gamma-hexachloro*cyclo*hexane). Table 1 gives results obtained with these insecticides applied as direct sprays[4] in refined kerosene. That synergism occurred is supported by the fact that the mixtures combined an enhanced toxicity with the rapid lethal action of valone. Kerr[5] gave data suggesting that synergism occurs between valone and pyrethrins applied to houseflies.

The larvæ of the Khapra beetle, *Trogoderma granarium* Everts, are exceedingly resistant to the contact insecticides in general use[6], and even lethal doses of these are very slow to kill. Mixtures containing valone with pyrethrins or gamma-BHC were therefore applied to larvæ, to discover whether the rapid action of valone might be useful in their control. As sprays in refined kerosene, the lethal action on the larvæ was rapid, but the synergism only moderate. However, as a dust on talc, a mixture of valone with gamma-BHC showed both a rapid lethal effect and marked synergism. Table 2 illustrates this. Even if mixtures of valone with gamma-BHC or pyrethrins should prove inapplicable to the practical control of *Trogoderma*, the existence of a formulation so toxic and swiftly lethal encourages the hope that a contact insecticide effective against these resistant larvæ can be found.

Table 1. Toxicity* to Flour Beetles, *Tribolium castaneum*, of Mixtures containing Valone, and of the Separate Constituents

Spray (concentrations, per cent w/v)	Spray deposit (mgm./10 sq. cm.) 2·5	3·7	5·4
2·0 per cent valone	0	0	32
0·3 per cent pyrethrins	0	2	10
2·0 per cent valone + 0·3 per cent pyrethrins	10	20	92
2·0 per cent valone	0	0	30
0·4 per cent gamma-BHC	0	4	20
2·0 per cent valone + 0·4 per cent gamma-BHC	12	58	88

* As shown by mortalities (per cent) in batches of 50 beetles kept at 25° C. for three days after spraying.

Table 2. Toxicity* to Larvæ of the Khapra Beetle, *Trogoderma granarium*, of a Mixture containing Valone and Gamma-BHC, and of the Separate Constituents

Dust (concentrations, per cent w/w)	Temperature 25° C.	30° C.
5·0 per cent valone	11	20
0·5 per cent gamma-BHC	0	0
5·0 per cent valone + 0·5 per cent gamma-BHC	77	100

* As shown by mortalities (per cent) in batches of 100 larvæ after four days exposure to the dusts.

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Relation between the Quality of Soybean Oil Meal and the Requirements of Vitamin B_{12} for Chicks

Varying results from some experiments with chicks, using pure vitamin B_{12} in all-vegetable diets, have led to the conclusion that the quality of the soybean oil meal used must be taken into consideration.

In two series of experiments, carried out in the early months of 1953, the addition of pure vitamin B_{12} to an all-vegetable diet gave ample and significant growth responses. In addition, the chicks in these experiments responded significantly to lowered calcium content in the diet, iron supplement or added vitamin D, although these factors were thought to be adequate in the diet.

In two further series, there was no growth response at all. The chicks fed the basal vitamin B_{12}-free diet grew at the same rate as the vitamin B_{12}-supplemented chicks. The other factors mentioned above also failed to give growth responses.

As a standard procedure in vitamin B_{12}-experiments on chicks at this animal experiment station, the method adopted by Rubin and Bird[1] is used. Day-old chicks from non-depleted hens are fed an all-vegetable diet for the first two weeks, and then

grouped and given the same basal diet with added supplements. In most instances this procedure has worked satisfactorily.

In the search for the causes of the discrepancies referred to above, attention was turned to the soybean oil meal. Before the last two experiments, a new batch of the same all-vegetable diet had been mixed up, and the soybean oil meal (*B* in Table 1) in this batch was of a much better quality than that previously used. This was of an under-heated, urease-active type, similar to samples *A* and *C*, the characteristics of which are given in Table 1.

Table 1. LABORATORY CHARACTERISTICS OF THE SOYBEAN OIL MEALS. Means of triplicate determinations

Characteristic	Soybean oil meal A	B	C
Antiproteolytic activity (ref. 7)	+++	−	+++
Water-soluble protein, per cent of total protein	23·8	6·3	21·8
Urease activity (ref. 3): (1) Time for colour change in min.	<5	>120	5
(2) *p*H-change	2·20	0·00	2·07
Urease activity (ref. 4), m.equiv. NH_3 per gm./hr.	4·3	0·0	3·3
Formaldehyde titration: Initial *p*H	6·66	6·53	6·61
ml. 0·1 *N* sod. hydrox. to adjust to *p*H 9·0	3·39	2·70	3·09
ml. 0·1 *N* sod. hydrox. to titrate back to *p*H 9·0 after formaldehyde	3·81	2·43	3·60
Phenolphthalein test, per cent transmission*	21·4	46·5	22·0

* Variation found, approximately: underheated soybean oil meals, 21-24; optimum-heated soybean oil meals, 45–60; overheated soybean oil meals, more than 60.

The three samples of soybean oil meal have been studied by laboratory methods, including determination of water-soluble protein[2], estimation of urease activity[3,4], formaldehyde titration[5], phenolphthalein adsorption test[6], and estimation of antitryptic activity[7]. All the laboratory determinations revealed the same fact, namely, that the soybean oil meals *A* and *C* were under-heated and of inferior quality compared with sample *B*.

Simultaneously, a feeding experiment with these samples given as 25 per cent supplements to a basal diet was started. The results from this experiment (given in Table 2) show significantly larger gains for the chicks on the diet with soybean oil meal *B* than on the other two samples.

Table 2. CHICK GROWTH EXPERIMENT WITH SOYBEAN OIL MEALS. GAIN UP TO FOUR WEEKS AND EFFICIENCY OF FEED. Diet: basal + 25 per cent soybean oil meal.

	Soybean oil meal A	B	C
No. of chicks	50	50	50
Per cent males	56	54	64
Gain, average males–females (gm.)	181	207	180
Feed consumed per kgm. gain (kgm.)	2·53	2·38	2·52

These findings indicate that chickens fed an under-heated, low-quality soybean oil meal are more rapidly depleted of their vitamin B_{12}-reserves, and thus have a greater need of vitamin B_{12} in the diet. Whether this is due to the antiproteolytic activity or the content of soyin (a thermolabile toxic protein, recently discovered by Liener and Pallansch[8]) in the low-quality meal is not clear. It seems probable, however, that the antiproteolytic activity, with the resulting decreased availability of essential amino-acids[9], does play an important part in the chicken's requirements of vitamin B_{12}. In addition, the calcium – iron ratio and the vitamin D content of the diet must be re-evaluated when using low-quality soybean oil meal.

It is intended to investigate these interrelationships in further experiments.

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Polygametic Zygotes as a Source of Polyploidy and Irregular Ratios in Yeast

Roman, Hawthorne and Douglas[1], on the basis of analysis of an ascus, suggested that irregular ratios in yeast may result from polyploidy. Lindegren and Lindegren[2] endorsed the idea on finding another exceptional ascus.

A source of polyploidy in yeast came to light while one of us (M. A.) was examining a cross between two single-spore cultures from a local strain of *Saccharomyces carlsbergensis* Hansen. A zygote, which was formed by the union of three gametes, was observed (Fig. 1). On further search, one more trigametic zygote was found. Both these zygotes were isolated by means of the micro-manipulator but they failed to give viable colonies.

Fig. 1. A zygote formed by the union of three gametes. × 750

No polygametic zygotes have been observed in yeast before, but there are a few records in Angiosperms where more than two gametes have probably taken part in the formation of an embryo[3].

The trigametic zygotes observed by us in yeast clearly suggest that they can be a source of triploid cells in crosses. Likewise, tetragametic zygotes will be a source of tetraploid cells. Roman *et al.* and Lindegren and Lindegren analysed asci from mass matings, and found asci organized presumably by tetraploid cells which may have come from tetragametic zygotes. The fact that we have so far not found tetraploid asci seems to be due to the fact that we isolate digametic zygotes and analyse progeny from such zygotes only.

The observation of trigametic zygotes shows that polygametic zygotes may be formed during mass matings of yeast. Such zygotes will give rise to polyploid cells which in turn will show polysomic inheritance and exhibit departures from 2 : 2 segregations.

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Sept. 10.

[1] Roman, H., Hawthorne, D. C., and Douglas, H. C., *Proc. U.S. Nat. Acad. Sci.*, **37**, 79 (1951).
[2] Lindegren, C. C., and Lindegren, G., *J. Gen. Microbiol.*, **5**, 885 (1951).
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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 18

Royal Geographical Society (joint meeting with the Photogrammetric Society, at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. E. H. Thompson: "A New British Stereoscopic Plotting Instrument for Aerial Photographs".

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. G. Ordish: "Economics of Crop Protection".

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Mr. D. E. Weimer and Mr. J. W. Price: "Some Aspects of Tinning by Immersion Processes".

Tuesday, January 19

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. D. M. S. Watson, F.R.S.: "Africa and the Origin of Man".*

British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. G. R. Cameron, F.R.S.: "Tissue Repair".* (Second of fifteen lectures on "The Scientific Basis of Medicine".)

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. W. Barnes: "A Single-Sideband Controlled-Carrier System for Aircraft Communication".

Society of Chemical Industry, Plastics and Polymer Group (at the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. P. Griffin: "Some Chemical and Technological Aspects of Silicone Resins".

Royal Society of Medicine, Pathology Section (at 1 Wimpole Street, London, W.1), at 8 p.m.—Discussion on "Phage Action on Bacteria".

Wednesday, January 20

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Smog".

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Monte Carlo Methods".

Eugenics Society (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. John Spencer: "Delinquent Behaviour—Some Unanswered Questions".*

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Magnetic Materials".

Society for Analytical Chemistry (joint meeting with the Royal Institute of Chemistry, in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 6 p.m.—Dr. D. W. Kent-Jones and Mr. G. Taylor: "Survey of a Report on the Determination of Alcohol in Blood and Urine".

Society of Chemical Industry, Corrosion Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. L. B. Pfeil, F.R.S.: "Metallurgical Aspects of Dry Corrosion".

Society of Chemical Industry, London Section (joint meeting with the Royal Institute of Chemistry, in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 6.30 p.m.—Mr. D. J. O. Brandt: "The Manufacture of Iron and Steel".

Thursday, January 21

Institution of Mining and Metallurgy (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Exhibition of film and discussion of paper on "The Observation of Dust in Mines by an Illumination Method" by W. B. Lawrie, A. T. Holman and E. B. James.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. D. Derry: "Curves of Real Order n in Projective n Space".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5.10 p.m.—Prof. C. G. C. Chesters: "Studies of the Decomposition of Seaweeds and Seaweed Products by Micro-organisms".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. A. J. Francis and Mr. T. H. Carr: "Electricity in the Wool Textile Industry".

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall, Institute of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. F. A. Shergold, Mr. P. A. Sabine and Miss June E. Morey: "The Correlation of the Mechanical Properties and Petrography of a Series of Quartz-dolerite Roadstones".

Institute of Welding, North London Branch (at The Polytechnic, Regent Street, London, W.1), at 7 p.m.—Dr. L. Reeve: "Steel Making and Welding".*

Royal Aeronautical Society (at the University, Southampton), at 7 p.m.—Mr. J. Smith: First Mitchell Memorial Lecture.

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. J. Sieger: "Impressions of American Television".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, January 22

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. R. E. D. Bishop: "Transient Vibration Problems".

Saturday, January 23

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Iorwerth C. Peate: "The Welsh Folk Museum".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer or Lecturer in Petrology, and a Demonstrator in Geology—The Registrar, The University, Nottingham (January 30).

Chair of Bacteriology—The Secretary, The University, Aberdeen (January 30).

Chemist-in-Chief for duties which will include responsibility, under the Medical Officer of Health and with a staff of 22 graduate chemists and ancillary staff, for control of the Council's central chemical laboratory and laboratories at two main drainage outfall works, for examination of quality of materials supplied to the Council, analyses in connexion with sewage disposal and river water condition, and statutory work under the Fertilizers and Feeding Stuffs Act—The Clerk of the Council (CL/G), The County Hall, London, S.E.1 (January 30).

Lecturer (with a good degree in mining and preferably with a first-class certificate of competency) in Mining, and a Research Assistant (with a good degree in mining, engineering or pure science) to the Professor of Mining—The Registrar, The University, Sheffield (January 30).

Principal Scientific Officer (with first- or second-class honours degree in either engineering, mathematics or physics) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, for mathematical work on stress distribution problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.684/53A (January 30).

Lecturer in Agricultural Chemistry in the Faculty of Agriculture and Horticulture—The Registrar, The University, Reading (February 1).

Lecturer (with special qualifications in invertebrate and marine zoology) in Zoology—The Registrar, The University, Reading (February 6).

Junior Lecturer and Research Assistant (with a Ph.D. degree, or its equivalent in chemistry or biochemistry) in the Department of Chemical Pathology—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (February 15).

Lecturer (with qualifications in cytology, genetics and plant breeding) in Botany—The Secretary, The University, Aberdeen (February 15).

I.C.I. Research Fellowships in Physics, Chemistry, Engineering, Metallurgy, and Pharmacology, or in any related subject—The Registrar, The University, Liverpool (March 1).

Librarian (with science degree, and working knowledge of French and German)—The Director of Research, Cereals Research Station, Old London Road, St. Albans.

Physicist (with first- or second-class honours B.Sc. degree or equivalent, and with an interest in light and optics) for work on colours of printing inks and the evaluation of print quality—The Printing, Packaging and Allied Trades Research Association, Patra House, Randalls Road, Leatherhead.

Physicists (with first- or second-class honours degree and some research experience) for (*a*) fundamental research on the diffusion of ions in the protein keratin, and related substances, using radio tracer methods, (*b*) fundamental research on friction and abrasion between high polymers and metals, (*c*) investigation of the mechanics of fibre movement using electronic and radioactive techniques—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

Physicist (with mathematical leanings) for experimental work on fibre assembling—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Scientific Assistant (with a degree in agriculture or natural science, and a knowledge of French and German, and the ability to write clear concise abstracts in English) for examining and abstracting world scientific literature on grassland and field-crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks.

Scientific Officers (with first- or second-class honours degree in a suitable scientific subject or equivalent qualification) in the Department of Scientific and Industrial Research for work in the following subjects: Physics (including radiology), Mechanical and Electrical Engineering, Mathematics, Aerodynamics, and Chemistry (metallurgical analysis)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.351/53A.

Senior Research Assistant (male) (with either a good honours degree in a biological science, or a degree in agriculture with post-graduate training in poultry husbandry, and with previous research experience) for programme of research on poultry husbandry, and an Assistant (male), for poultry experimental work, with particular reference to table poultry production and marketing—The Bursar, Harper Adams Agricultural College, Newport, Shropshire.

Survey Entomologist (with good honours degree in entomology) in the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, for work in connexion with tsetse surveys in Kenya, Uganda and Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 77/88/04.